SCIENCE

CONTENTS

THE INFLUENCE OF CHEMISTRY ON CIVILIZATION [1]

THE future of a country depends on the education of its youth, and the education of its youth must be in competent hands. Whoever first spoke these truisms knew his subject, for we have only to look at those countries where education is not enforced, or even easily attained, to find a country so backward that its relations with the rest of the world are stunted. In many of the countries of Europe illiteracy is universal. In Hungary, for example, we still find that the signs in front of a shop are painted pictures of the wares offered for sale, because many intending purchasers can not read, but they know that the graphic portrayal of a hammer and a saw indicates that tools are sold within. What have those countries like Roumania, Bulgaria, Bohemia, Hungary, Russia, and dozens of others, ever amounted to, and what are their commercial relations with the rest of the world, compared with Germany, France, England or the United States?

The law in the United States and England recognizes only three professions—law, medicine and theology—and long before law and medicine became professions, theology was the only profession, because only the priests and the scribes could read and write. The theologians of ancient times were the early teachers, and one of the first institutions of learning which was carried on systematically (excepting the teachings of Gotama and Confucius) was the Sanhedrin where the Mosaic and

[1] Address by the chairman of the Society of Chemical Industry.

Deuteronomic codes were taught, and the twenty volumes of the Talmud are to-day the classics of that college of learning.

It so happened that preachers became teachers, and down to our present time we have many colleges, all over the world, where preachers are in charge and dictate the policy of the institutions.

I must not be misunderstood in any criticism which I am about to make, for I have no quarrel with any religious profession, but if we examine into the mental status, and analyze the mind of the theologian, we find that he is accustomed, once or twice a week, to preach from the pulpit, relieving his mind of opinions on questions and subjects which have been thrashed out time and again, and from the very nature of his audience, and the sanctity of the edifice from which he speaks, no one contradicts, no one argues, no one says him nay, until by that mental process with which we are familiar, he believes himself unanswerable, and takes even his glittering platitudes as facts undeniable.

Such a man placed at the head of a university where science is taught is evidently not as good as a man who has been trained to judge cause and result, and whose scientific work has been criticized by his equals, and as a comparison we have at least three large and well-known colleges that I know of—and, for all I know, there may be many more—at whose head there are, or were, chemists and scientists of distinction, and every one of these has turned out men who have given a good account of themselves. Nor do I want to except those excellent universities which are guided by literarians and other intellectually developed men other than theologians, for the success of those colleges is equal, comparatively, to those presided over by chemists. A school of medicine is best presided over by a doctor, a school of engineering by a man who is educated in one of its branches,

a military school by a soldier, and a school of theology by a minister of the gospel. Our greatest success in schools of chemistry will therefore come from the very chemists who direct their policy.

Chemistry needs no sponsor, but its effect on civilization has been more marked than that of any other science. True, it has reached out and taken electricity and physics as its aides, but withal, engineering made but little progress until steel and cement, two chemical products, were cheapened, simplified and made universal. Medicine has claimed great honors, but the masterful work done in coal tar chemistry, in the production and discovery of synthetic drugs, the discovery of anesthetics, the marvelous work done in the metabolism of matter, the excellent analytical schemes for the waste matter of the tissues, are all due to the researches of chemistry, and their civilizing influence is greatly felt.

Many a chapter has been written on the regeneration of Germany. Where once barren fields stood, so barren that foodstuffs would not grow, there have arisen vast works bristling with the stacks of factories, and thousands of commercial flowers grow where once not even a weed would flourish. And in all these plants chemists are working, controlling the products that are made, and creating new things, and for every new and useful compound more work is found, and whereas, emigration was the rule in Germany thirty to fifty years ago, and its best people left it like rats from a sinking ship, to-day many are immigrating, for it's a flourishing land which chemistry has retrieved. Germany was always poor up to ten or fifteen years ago. With one or two possible exceptions, no vast industries existed, and it had nothing to export, but to-day its exports are enormous, its people prosperous, in sad comparison to its neighbor, Austria, where

industry is making slow progress compared with Germany.

The United States is practically an agricultural country, for its wheat, cotton, flaxseed, corn, cereals and lumber are larger than its manufactures, yet it soon will lead in metals, and it is fast coming to the front in its chemical industries.

The engineer may brag of his skill, but he has done nothing greater than the pyramids, nor finer than the temples of Greece and Egypt. The monuments he has wrought in steel were given to him by the ability of the chemist to control carbon in iron, and the economic principle involved in the production of steel supplies work, puts money into circulation, and keeps the wheels turning.

If it were not for chemistry and the knowledge that has been gained in the fertilization of soils, we would have often exhausted the miles of ground which have made this country what it is, and even now the very work which is going to maintain the entire civilization is the production of nitrogen from the air, a purely chemical investigation which may be the greatest civilizing factor of the age.

Twenty-five years ago the chemist was a man who made analyses, and whose knowledge was confined to inorganic materials, and a few organic substances. To-day there are very few analytical chemists in ratio to the population, for nearly all works maintain laboratories where chemists are employed and researches are continued, so that by-products which formerly were waste, to-day are converted into commercial products.

The brewing industry years ago looked upon the chemist with considerable doubt, for the first influence the chemist had upon the brewing industry resulted in the manufacture and use of bicarbonate of soda to produce froth, and salicylic acid to prevent fermentation. It took the chemist many years to convince the brewer that he could do without these materials, and to-day the modern brewmaster has a chemical training and conducts the process of brewing upon scientific principles.

It is only a few years ago that some of our members assembled at the grave of Priestley and marked the centennial of the discoverer of oxygen.

For a science so young, its civilizing influence is enormous, and there is no doubt that the rapid progress which it made in the nineteenth century will be outstripped in the twentieth, for the control of our foodstuffs, the application of the raw materials in the earth, and the refining of metals, create positions, give progress to a country, and help largely in the establishment of that profession in which we are all factors.

Maximilian Toch
New York City

A PROBLEM IN LABORATORY ADMINISTRATION—ITS SOLUTION

A reading of the excellent article by Professor Baskerville on " Laboratory Organization " which appeared recently in Science, has prompted the writer to speak of one of the difficult phases of laboratory administration and an attempt at a suitable and efficient solution of the same. This note is written in the hope that it may offer some suggestion to those working on the same general question, modified, of necessity, by local conditions.

For a number of years there has been a steadily increasing growth in the number of students taking general elementary chemistry in this laboratory, until the gross registration for the present academic year shows an enrolment of 725. For lecture purposes this number is divided into four sections of 220, 220, 180 and 105 each; for quiz into groups of 25 to 30 each. For laboratory purposes, the classes are divided into eight sections, which are accommodated in two large laboratories, each containing 126 desks of three lockers each, or a total of 756 lockers. The general

plan for laboratory work is to assign three students, each of a different section, to every desk, one locker being provided for every person. The laboratory sections vary in size from 80 to 110 students, and it thus becomes apparent at once that assignment of lockers on the above basis becomes increasingly difficult as the total number of students approaches the total number of lockers. This phase of laboratory administration together with that arising from the registration of students during the academic year; unavoidable transfers in sections due to change of daily schedule; students withdrawing from the

given; the Monday and Tuesday afternoon laboratory division (lockers 1, 4, 7, 10, 13, etc.) are all indicated by yellow pegs; Thursday and Friday afternoon division (lockers 2, 5, 8, 11, 14, etc.) by red pegs; Wednesday and Saturday division (lockers 3, 6, 9, 12, etc.) by white pegs, other sections by other colors. After all the students have been assigned lockers, a record of the same is made on numerically tabbed index cards and thus a complete record of both laboratories is kept in the office of this division of the department of chemistry. A glance at the details of the diagram shows that each board can be folded without the

TOP VIEW OF BOARD – OPEN

END VIEW OF BOARD – CLOSED

DIAGRAM OF DESK
SHOWING NUMBERS
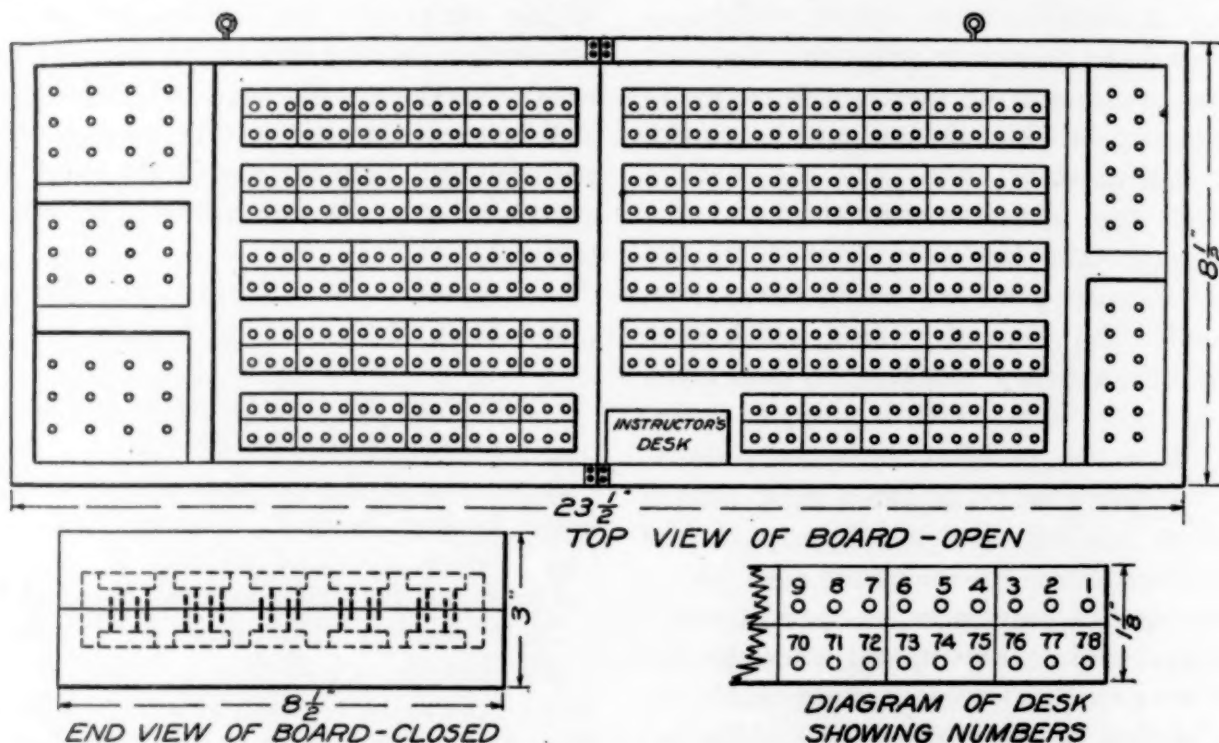
university; rearrangement of students in order to economize the time of the teaching force; these with others that readily suggest themselves have been questions demanding quick and efficient solution. In order to meet these situations successfully and with the greatest economy in time, the following device has been prepared. Two key-boards have been constructed, each being a model of the general desk arrangement of the laboratories (see design for details). In the numbered holes are placed steel dowel pins, painted in various colors. To illustrate better the general assignment above mentioned and the use of the board for these purposes, an actual case is

least danger of the pins becoming displaced. By means of an alphabetical card index (5" × 4"), used in conjunction with the above, there is kept always at hand such data in reference to the student as name, college, locker number, number of course, test grades, laboratory grades, quiz grades, final grades, term standing, laboratory section, quiz section, lecture section, etc. One further example of this system will illustrate its use; notice is received by the department of chemistry from the registrar that John Smith has withdrawn from the university. On receipt of the same, the alphabetical index is consulted for locker number of the student, say number 12. The with-

drawal and date are noted on this card, which is then refiled. Card 12 of the numerical index is withdrawn and replaced by a new one, at the same time peg 12 is taken from the board and placed in the side compartments, the vacant peg-hole showing at a glance the availability of this locker. In assignment of available lockers, one need only bear in mind that two pegs of the same color can not be placed on the same desk, and thereby conflict will be avoided. Thus, without multiplying examples, it at once becomes apparent that this system gives one a ready and simple control of the laboratories. By this system, classes of seven hundred are handled with great facility.

The writer wishes to express his thanks to Mr. Harry Mougey, of this laboratory, for several suggestions made in the construction of the above board.   WM. LLOYD EVANS

OHIO STATE UNIVERSITY,
    September 8, 1909

EDUCATIONAL AIMS IN THE TEACHING OF ELEMENTARY GEOMETRY, HISTORICALLY CONSIDERED [1]

THE two educational aims that have stood out distinctly in the history of the teaching of geometry are the practical [2] and the logical. Of course in the early development of geometry the term teaching can not be used with its modern significance. The practical side of geometry was developed by the Babylonians, the Egyptians and the Romans; the logical by the Greeks. In the medieval universities the little geometry taught was according to Euclid. England has followed the same standard to the present day. The other European countries, for the most part, have combined both of these aims, and this obtains to-day, with the empha-

[1] See the author's "A History of the Teaching of Elementary Geometry," Teachers College Contributions to Education, No. 23, for the original and secondary sources consulted. The present article is not an integral part of the larger work, but material from the latter is utilized in the former.

[2] The term practical is used with reference to the applications of geometry within the field of mathematics or in the related fields of science.

sis on the logical. The same is true in the United States. A third aim in the teaching of geometry arose when the secondary schools began to assume the character of preparatory schools for the universities. The last hundred years have seen this generally brought about, and within the last fifty years it has been fully systematized in the various countries. In treating these several aims it is impossible to completely separate them.

The early Egyptians and Babylonians developed geometry as a means toward a practical end. Both nations were interested in astronomy, and hence a rudimentary geometry found a place with them. The Egyptians employed geometric principles in the building of their pyramids and in surveying. They measured lengths and areas, they built solids of regular design, they showed some skill in geometric drawing in their mural decorations. With all this they experienced the necessary propædeutics for a developed science, yet this development never came. Whether it was the lack of God-given powers or due to the conservatism of the priestly class, that sacredly guarded the learning, one can only conjecture.

The Romans, also, valued geometry for its utility, employing it in architecture and in surveying. But, unlike the Egyptians, they had the learning of other nations to draw upon. This development in architecture and surveying was marked in the first century before and the first century after Christ. Euclid had written his "Elements" approximately three hundred years earlier. Archimedes had already developed geometry as applied to mechanics, and Heron of Alexandria, who studied and wrote on practical geometry and surveying, lived in the early years of this "Roman" period. The work of Heron influenced the Roman surveyors, but Euclid found little favor with the Romans. When the "Elements" was recognized at all, it was that it might be of aid in the training of the orator, which was, for the Romans, a practical aim. In like manner the Hindus and Arabians studied geometry primarily for its practical value, although both of these nations were largely dependent upon the Greeks for their knowledge of geometry.

The nations that have been considered thus far emphasized only the practical side of geometry, and we find with them no plan of education that provided for its systematic instruction. The early Christian schools taught geometry in a small way, but the practical was almost entirely neglected. The medieval universities made provision for the applications of geometry, but such work was independent of Euclid.

The Greeks were the first nation that developed and consistently taught a logical system of geometry. Although they were interested in astronomy and the physical sciences (which undoubtedly stimulated their study of geometry), yet the practical was completely divorced from the logical, as is shown in the text of Euclid. The chief function of education, according to the old Greek idea, was the perfection of the human being, body and soul. Hence gymnastics and music constituted almost entirely the program of studies for the growing boy. When the new education with its philosophy and mathematics entered into the Greek life, it served as the completion of an edifice whose foundations had already been laid. Hence the logic of geometry thrived in Greece. But in the development of this science, the Greeks were stimulated by a sort of practical aim in attempting to solve the three famous problems of antiquity: the quadrature of the circle, the duplication of the cube, and the trisection of any angle. In the actual teaching of the subject, however, the Greeks were more interested in the chain of reasoning than in the subject-matter itself.

Logical geometry next found a place in the medieval universities. Under the influence of monasticism and mysticism the church schools were more interested in religious than in intellectual things. Then scholasticism arose and dominated European education from the eleventh to the fifteenth century. It sought " to bring reason to the support of faith," and logical inquiry was stimulated. The universities began their careers under such influences, and when Euclid became known to medieval Europe, it found a place in the curricula of these institutions, where it was taught in the highest class. Undoubtedly it was looked upon as the instrument that completed and knit together the logical faculties of the mind. The universities did not neglect science. In particular the " sphæra " was studied, but it bore no relation to the logical study of geometry. A thing for us to remember is that these institutions followed the example set by the Greeks. Geometry and the physical sciences were both studied, but the former was developed without any reference to the latter.

In the teaching of geometry, the different European countries have held to the strictly logical in varying degree. Italy has Euclidean traditions, but England above all has taught geometry primarily on the logical basis. Euclid has there reigned supreme. Until recent years English higher education has meant the education that fits for the so-called higher callings. The public schools, which prepare largely for the universities, have had this same conception. Any training that smacked of " trade " was not considered to be a part of the education of an English gentleman. The result has been that the classical side has been particularly emphasized and practical education has been almost neglected. In recent years the modern university movement in England has furthered technical and industrial education, and we now find secondary and higher technical schools that are beginning to fill this gap in the English school system.

Thus far we have mentioned the marked tendencies among certain nations and institutions to hold either to the practical or the logical in the teaching of geometry. With reference to other nations, Germany and France, for instance, have never held to the rigors of Euclid, and Russia has begun only in comparatively recent years to emphasize the scientific teaching of geometry. Let us look into the aims in some of those countries where the extremes of aim have not been so disassociated.

The Renaissance of the fifteenth and sixteenth centuries brought no change in the teaching of mathematics in the universities. This result could hardly be expected from a movement entirely classical in its nature. It was not until the latter part of the seventeenth century, under the influence of realism, that

the universities began to change the character of their work, and modern science was included in the curricula. The geometry taught in the secondary schools of Germany up to the seventeenth century was taught largely in connection with astronomy and surveying, copied after the work done in some of the medieval schools. The logical aim became more prominent by the beginning of the eighteenth century when science began to assume its more modern form.

In Russia, geometry was first taught from the practical standpoint. The logical aim was long in getting recognition. It was not until the end of the eighteenth century that geometry received any great attention as a science. In France, the early texts show that the practical in geometry was valued as well as the logical. In Holland, the beginning was practical, the eighteenth century marking a more logical trend, when the teaching was made systematic. In the United States, the first geometry taught was of a practical nature, but the English influence was soon felt, and it was not until the first quarter of the nineteenth century that the more practical geometry of the French began to replace the English Euclids.

Another aim has characterized the teaching of geometry, an aim different from the two already considered, but still not standing apart from them. It is associated with the study of geometry as a preparation for advanced work in mathematics. This aim is a recent one in the teaching of geometry. Before the latter part of the eighteenth century, in no strict sense could the secondary schools that have here been considered be called preparatory schools for the higher institutions.

It was not until 1788 that the Prussian government required an examination from all who entered the universities, and it seems that this was not at first rigidly enforced. One may safely judge that previous to 1788 the aim of preparing for advanced study was not a dominant one in the gymnasia. On the creation of the lycées in France by Napoleon in 1802, these schools began to assume the character of preparatory schools for the university and the various government schools.

In England, the secondary schools did not begin to teach Euclid until the early part of the last century, and it was not required in general until about the middle of that century. It has been only within fifty years that these schools have in any strict sense prepared for the universities. In Russia, students at first passed from the seminaries and the ecclesiastical academies into the universities, but in 1759 the gymnasia began to act as preparatory schools. The secondary schools of Holland began to prepare for the university in 1815, but as far as geometry was concerned, the requirements were not strictly defined. In the United States the universities did not require geometry for entrance before 1844. Since that date the high schools have assumed more and more the function of preparing students for advanced work in the universities.

One of the results of this close relation between the university and the secondary school has been an improvement in the teaching of geometry from the scientific standpoint, but, in the United States at least, while the teaching of geometry has been better developed logically, its practical side has been correspondingly neglected in the high schools.

ALVA WALKER STAMPER

CHICO, CAL.

A NEW NAME FOR A NEW SCIENCE [1]

THE following list, though noticeably brief, attempts to include all books and memoirs in which the facts of history of a personal nature have been subjected to statistical analysis by some more or less objective method. Such researches may be made to contribute to the science of eugenics. They also stand upon the border line of the allied sciences, psychology, anthropology and sociology. Since investigations of this nature contribute to several sciences, and at the same time primarily

[1] "Some Desiderata in the Science of Eugenics and Bibliography of Historiometry," by Dr. Frederick Adams Woods. Reprinted from Vol. V. of the American Breeders' Association Report of the Meeting, held at Columbia, Mo., January 6, 7 and 8, 1909. Report of the Committee on Eugenics. Bibliography of Historiometry (Quantitative History) now printed for the first time.

to the philosophy of history itself, it seems necessary to have some special name to designate this class of work. The word "biometry," already in general use, does not meet the requirements. It fails to express the primary value of this class of research, namely, elucidation of the philosophy of history for its own sake, and also fails to suggest that the work should be carried forward by the historians themselves. I propose the word "historiometry," derived from the Greek ἱστορία, history, and μέτρον, measure. Historiometry bears the same relation to history that biometry does to biology. It may be noticed that these investigations treat only of groups of individuals. I am already convinced from the indications of several researches which I have now under way, that the quantitative method may be successfully applied to historical events of a more general character.

BIBLIOGRAPHY OF HISTORIOMETRY

de Candolle (Alphonse). "Histoire des sciences et des savants depuis deux siècles." Genève, etc. (H. Georg), 1873. Contains lists of scientific names objectively (impersonally) compiled.

Cattell (J. McKeen). "A Statistical Study of 'Eminent Men." *Popular Science Monthly*, February, 1903, pp. 359–377. [Abstract in *Psychological Review*, March, 1895.] The names of a thousand eminent men of all time are here arranged in the order of their eminence by the strictly objective, and valuable "space method." Attempt should be made to test the limits of the accuracy of this method by comparing these names with those selected by other methods.

Cattell (J. McKeen). "A Statistical Study of American Men of Science." *Science*, November 23, November 30, December 7, 1906. Although the facts are not drawn from history, they are useful as a check to compare with historical statistics. The names were selected by the "method of voting."

Ellis (Havelock). "A Study of British Genius." London (Hurst & Blackett), 1904. [First appeared in *Popular Science Monthly*, February–September, 1901.] A valuable study based upon the "Dictionary of National Biography." Contains lists of British men of genius and talent, objectively derived and useful for further study.

Galton (Francis). "Hereditary Genius. An Inquiry into Its Laws and Consequences." 2d edition. London (Macmillan), 1892. The

earliest of biographical statistical studies, first published in 1869. Many of the lists of names are not compiled by any strictly objective method.

Galton (Francis). "English Men of Science, Their Nature and Nurture." London (Macmillan), 1874. Fellows of the Royal Society.

Galton (Francis) and Schuster (E.). "Noteworthy Families." London (Murry), 1906. Families of scientific men objectively studied.

Jacoby (Paul). "Études sur la sélection chez l'homme." Avant propos par Gabriel Tarde. 2d edition. Paris (Alcan), 1904. The last quarter of this work dealing with the origin of French men of talent has decided scientific value. The first portion of the book deals with royalty, *le pouvoir*, contains no statistical treatment, and is entirely misleading.

Lorenz (Ottokar). "Lehrbuch der gesammten wissenschaftlichen Genealogie." Stammbaum und Ahnentafel in ihrer geschichtlichen, sociologischen und naturwissenschaftlichen Bedeutung. Berlin (Hertz), 1898. Suggestive at the time it was written, but contains scarcely any statistical treatment.

Odin (A.). "Genèse des grands hommes gens de lettres français modernes." 2 vols. Paris (H. Welter), 1895. A study of 6,382 French men of letters. Valuable for its facts. The conclusions are often unwarranted.

Woods (Frederick Adams). "Mental and Moral Heredity in Royalty: a Statistical Study in History and Psychology, with 104 Portraits." New York (H. Holt), 1906. [Abstract in *Popular Science Monthly*, August, 1902–April, 1903. Brief abstract in *Psychological Review*, March, 1902.] The individuals are included in the study by a strictly objective plan. Attempt is made to reduce the subjective element to a minimum while grading them to a scale of ten, by averaging opinions of historians. Conclusion that heredity outweighs environment is arrived at by several statistical methods. The general method of "averaging opinions" is shown to be practical and to give orderly results, harmonious with other researches in heredity. Human heredity shown to be "alternative" (non-blending).

"The Great Men of France (XIXth Century)." From London *Times* in *Science*, January 11, 1907. Names were obtained by popular vote.

Frederick Adams Woods

Massachusetts Institute
of Technology

SCIENTIFIC NOTES AND NEWS

THE Royal Society has awarded the Copley medal to Dr. George W. Hill, of West Nyack, N. Y.

PROFESSOR THEODORE W. RICHARDS, of Harvard University, has been elected to corresponding membership in the Royal Prussian Academy of Sciences of Berlin.

SIR JOSEPH LARMOR, Professor Felix Klein and Professor H. Poincaré have been elected honorary members of the Calcutta Mathematical Society.

LIEUTENANT E. H. SHACKLETON, the antarctic explorer, has been created a knight by King Edward.

THE first fellowship established under the will of the late Dr. Sorby, has been awarded to Dr. Jocelyn F. Thorpe, F.R.S., who will work on the chemistry of the imino-compounds.

ARTHUR M. BANTA, Ph.D. (Harvard), has resigned the professorship of biology at Marietta College to accept a position on the staff of the Station for Experimental Evolution at Cold Spring Harbor, N. Y. F. H. Krecker, Ph.D. (Johns Hopkins), has been elected to the position at Marietta College.

MR. TRYGVE JENSEN, a graduate of the department of electrical engineering of the University of Illinois, has recently been awarded the prize offered by the Edison Medal Committee of the American Institute of Electrical Engineers. The title of Mr. Jensen's thesis is "The Operation of a 100,000-volt Transformer." The prize consists of a diploma and a cash award of $150.

THE University of Kansas sent two collecting parties into the field last summer. One, consisting of Professors C. E. McClung, W. J. Baumgartner, R. L. Moodie, W. R. Robertson with Mr. Ward Cook, devoted itself to obtaining from the waters of Puget Sound an extensive collection of specimens for class use. These will be shared with the high schools and colleges of Kansas in the endeavor to secure as good teaching as possible. The other party, consisting of Mr. H. T. Martin and two assistants, secured a large and valuable series of fish specimens from the Niobrara of Kansas.

Several new forms were obtained and much good material for further comparative study of known species.

THE program of the meeting of the American Philosophical Society on November 19 consists of a paper, by Professor C. L. Doolittle, on Halley's comet, illustrated with lantern views.

AT a meeting of the American Antiquarian Society, held at Worcester, October 20, Dr. W. C. Farabee, of Harvard University, presented a paper on "Some Customs of the Macheyenga Indians of the Upper Amazon."

DR. WILLIAM R. BROOKS, director of Smith Observatory and professor of astronomy at Hobart College, delivered his illustrated lecture on "The Wonders of the Heaven," before the Buffalo Society of Natural Sciences, on November 5.

PROFESSOR JOSEPH JASTROW, of the department of psychology of the University of Wisconsin, has been appointed by the trustees of Columbia University to give graduate courses in psychology in that institution during the second semester of this year, and to deliver a series of eight public lectures.

SIR AUGUSTUS WALLER delivered a series of lectures on the Hitchcock foundation at the University of California, beginning on September 18. The subject of the lectures was "Physiology the Servant of Medicine."

PROFESSOR FREDERIC S. LEE, of Columbia University, has recently given the following addresses: On October 22, at New Haven and Hartford, before the section on Hygiene of the Connecticut State Teachers' Association on "The Nature of Fatigue"; on November 3, at Burlington, at the opening of the fifty-seventh session of the College of Medicine of the University of Vermont, on "A Defense of Sanity," and on November 12, an address to the graduating class of the Training School for Nurses of the New York Infirmary for Women and Children.

BEGINNING Friday, November 12, Professor S. A. Mitchell, of Columbia University, gives a course of six lectures on "Modern Astronomy" in Philadelphia, for the University

Extension Society. The subjects are: (1) "The Birth of the Moon," (2) "The Light and Heat of the Sun," (3) "Astronomy at the North Pole," (4) "Eclipses of the Sun," (5) "Halley's Comet," (6) "Is Mars Inhabited?"

At the inauguration of the new rooms of the Royal Society of Edinburgh, November 8, Sir William Turner, president of the society, delivered the address, which was followed by a reception.

The eighty-fourth Christmas course of juvenile lectures, founded at the Royal Institution in 1826 by Michael Faraday, will be delivered this year by Mr. W. Duddell, F.R.S. His subject is "Modern Electricity," and the first lecture will be given on December 28.

There will be a U. S. Civil Service examination on December 15, to fill the position of entomologist in the Bureau of Science at Manila, with a salary of $1,600.

By an arrangement with the *Centrale Stelle,* Kiel, the Lowell Observatory has been made the telegraphic distributing center for planetary news in America.

The American Anthropological Association and the American Folk-Lore Society will meet in affiliation with Section H of the American Association for the Advancement of Science at the meeting to be held in Boston, December 27, 1909, to January 1, 1910. Members of these two societies and of Section H, who contemplate presenting papers at this joint meeting of anthropologists should send immediately titles and abstracts of papers to Dr. George Grant MacCurdy, Yale University, New Haven, Conn., who is responsible for the combined program.

Members of the American Association for the Advancement of Science who are affiliated with Section D, Mechanical Science and Engineering, are invited to contribute to the program of the section for the Boston meeting. Those intending to do so are requested to so advise the secretary, Professor G. W. Bissell, East Lansing, Mich.

The twenty-seventh stated meeting of the American Ornithologists' Union will be held at the American Museum of Natural History in New York City, beginning on the evening of December 6. The evening session will be for the election of officers and members, and for the transaction of routine business. Tuesday and the following days of the session will be devoted to the presentation and discussion of scientific papers and will be open to the public. Information regarding the meeting can be had by addressing the secretary, Mr. John H. Sage, Portland, Conn.

The annual meeting of the American Nature-Study Society will be held in Boston on January 1, 1910. The topic for discussion is the course in nature-study for elementary schools. Both the biological and the inorganic aspects of nature-study will be considered.

The American Society of Animal Nutrition will meet at Chicago on November 27, in connection with the International Live-stock Exposition. Dr. H. P. Armsby, of the Pennsylvania State College, will give the presidential address. Professor H. R. Smith, of the University of Nebraska, will present a paper on "The Value of Feeding Experiments to the Farmer" and the reports of several committees will be presented.

The ninth meeting of the Central Association of Science and Mathematics Teachers will be held at the University of Chicago on November 26 and 27. The work of this association is mainly concerned with the problems of the secondary schools in teaching science and mathematics. It developed the correlation of secondary school mathematics and originated the so-called "new movement" among physics teachers, and is now engaged in considering the fundamentals of the several sciences as presented in secondary schools. At the general session on November 26, Professor Chamberlin, of the University of Chicago, will give some account of his recent studies in China in an address entitled "Certain Features of China, Physical and Humanistic." Principal James E. Armstrong, of the Englewood High School, Chicago, will give some conclusions based upon four years' experience with segregated classes in high school, in an address, "The Advantages of Sex Segregation in High

School." Among other educators on the program are: Professor Richard E. Dodge, of Teachers College, Columbia University; Professor A. A. Michelson, University of Chicago; Dr. Norman A. Du Bois, Case School of Science, Cleveland; Professor Chas. R. Mann, University of Chicago; Dr. J. A. Drushel, Teachers College, St. Louis; Professor J. W. A. Young, University of Chicago; Professor Fred. T. Charles, University of Illinois.

AT the invitation of the staff of the department of natural history of the College of the City of New York, twenty-two working biologists from the various laboratories of New York dined in the faculty dining rooms of the college on Tuesday evening, November 9. After the dinner, which was served by the college caterer, the men inspected the biological laboratories of the department. The following institutions were represented: the Rockefeller Institute, The College of Physicians and Surgeons, The New York Hospital, The College of Pharmacy, Cornell University Medical College, Columbia University and Barnard College.

A RUBBER pilot-balloon sent up on October 8 from Blue Hill Observatory to determine the air currents, was visible for one hour and ten minutes and in that time rose to a height of about 18,000 meters, or 11¼ miles. Probably this is the greatest height at which atmospheric movement has been observed in the United States, since the highest clouds measured at Blue Hill do not exceed 15,000 meters, or 9½ miles.

THE magnetic survey yacht *Carnegie* had many distinguished visitors while at Falmouth, England, among them being the Earl of Plymouth, the Honorable W. Peel, Sir Arthur Rücker and Professor Arthur Schuster. The latter two gentlemen made official visits as members of the advisory board of the department of Terrestrial Magnetism of the Carnegie Institution of Washington. The magnetic data already secured on board the *Carnegie* have been communicated to the principal hydrographic offices and were presented by General M. Rykatscheff before the Russian Geographic Society, St. Petersburg,

on October 27. The director, Dr. L. A. Bauer, returned to Washington on November 11. The *Carnegie* left Falmouth under the command of Mr. W. J. Peters, on November 8, bound for Madeira and Bermuda.

IT will be remembered that the late Dr. H. C. Sorby, F.R.S., of Sheffield, bequeathed a sum of £15,000 to the Royal Society of London to be held in trust for the establishment of a professorship or fellowship for original scientific research, the testator expressly desiring the professorship or fellowship thus founded to be associated with the University of Sheffield. Accepting this trust, the council of the Royal Society appointed a committee to confer with representatives of the University of Sheffield with the view of drawing up a scheme for giving effect to the intentions of Dr. Sorby's will. A scheme, prepared by this committee for the establishment of a "Sorby Fellowship for Scientific Research" to be associated with the University of Sheffield, has now been approved and adopted by the council of the Royal Society, and by the senate and council of the University of Sheffield. The fellow will be required to carry out his research, when possible, in one of the laboratories of the University of Sheffield, and provision is made under the regulations for the setting aside of a sum not exceeding £50 a year to form an apparatus fund, from which grants may be made from time to time to the fellow for the purchase of special apparatus and material required in his research. The stipend of the Sorby Research Fellow will probably be about £500 per annum.

THE geological department of the University of Wisconsin has recently completed a relief map of the state of Illinois for the University of Illinois, on a scale of five miles to the inch horizontally and 1,320 feet to the inch vertically. The low relief of the prairie region between the Mississippi, the Ohio and Lake Michigan, with the contrasting sharply cut stream valleys and gorges in the lead and zinc district in the northwest and the Ozark plateau extension in the extreme south are well shown on the map. The topography is based on the contour maps prepared for the

Chicago World's Fair and the topographic maps of the United States Geological Survey and the Mississippi River commission. Most of the geology is from the geological map prepared for the Illinois Geological Survey.

After making 15,000 tests on 50 railway bridges on the lines of eight different railroad systems of the country, Dean F. E. Turneaure, of the college of engineering of the University of Wisconsin, is now compiling data which it is expected will eliminate the element of guess work in allowing for speed strain in bridge design. Heretofore there have been few actual data on the comparative effects of speeds on the different parts of bridges, so that allowance for such strain had to be made largely by guess. A few experiments were made with machinery imported from Germany, including those of Dean Turneaure in 1907 on the St. Paul road, but the difficulty and expense prevented further investigation until Dean Turneaure invented a machine of his own for the work. This is an electrical instrument which makes an autographic record of every slightest bending, shortening or stretching of the part of the bridge to which it is attached, when a train is crossing the bridge. Twelve duplicates of the machine were made in the shops of the college of engineering, and used simultaneously on different parts of the bridge, giving accurate data for comparison. Since it seems likely that not all of the fund of $9,000 subscribed by American railroads to defray the expense of the investigation will be used in this series of tests, it is planned to start a second series of experiments involving a different feature.

Nickel and cobalt are not produced in large quantities in the United States, the domestic output of nickel in 1908 coming from only two or three places and that of cobalt from only one place. Both metals are produced by a lead company at Fredericktown, Mo., and some nickel ore was shipped from Bunkerville, Nev. Other nickel deposits are known in various parts of the country, but no work of importance was done on them during 1908. Some nickel salts were made at a New Jersey refinery from electrolyte solutions obtained in the refining of copper. In copper refining by electrolysis nickel contained in the raw copper anodes goes into solution in the electrolyte, and unless the solutions are changed before the amount of nickel reaches 1 per cent. of the solution, nickel is deposited with the copper. It is said that this causes the copper to lose some of its toughness. Before this factor in electrolytic refining was found to be serious it was impossible to make electrolytic copper equal to the best Lake Superior brands, but the refiners say that since this discovery they can make electrolytic copper equal to any other, and even superior to some in electroconductivity.

UNIVERSITY AND EDUCATIONAL NEWS

The provisions of the will of Mr. John Stewart Kennedy have not been officially announced, and the reports which have been published are not exactly correct. Mr. Kennedy bequeathed one half of his vast estate to public purposes. The greater part of this estate is to be divided into sixty-four parts, and the bequests have been made on the basis of these parts. Thus to Columbia University and the other institutions receiving the largest bequests are devised three of the parts, not $2,225,000, as has been stated. The announcement was based on the supposition that the value of these parts would be $750,000, and it is believed that this is a very conservative estimate. If certain of the heirs die without issue, the property bequeathed to them is to be divided into four equal parts to be given, respectively, to Columbia University, the New York Public Library, the Metropolitan Museum of Art and the Presbyterian Hospital of New York City.

It is reported by cablegram that Mrs. Francisca Speyer has bequeathed more than $8,000,000 to public purposes. The bequests include $1,000,000 to the Frankfort Academy of Social and Commercial Science, and $1,000,000 for the furtherance of the research into the subject of cancer and lupus.

Mr. William D. Sloane has given $150,000 to the College of Physicians and Surgeons of

Columbia University for an addition to the Sloane Maternity Hospital.

THE New York *Evening Post* states that the bequest of Dr. Levi Ives Shoemaker, of Wilkes-Barre, Pa., of $500,000 to the Medical School of Yale University will, at the expiration of a life interest, give the school an amount more than double its present funds, which, by the last report of the university treasurer, were $222,687.

DR. G. B. LONSTAFF, of New College, Oxford, has given £2,400 to the university for forming an additional endowment for the maintenance and support of the Hope department of zoology.

THE laboratory of physics of the University of Illinois will be formally opened on November 26. President Pritchett, of the Carnegie Foundation, will make the dedicatory address, preceded by short addresses by the governor of Illinois, the president of the board of trustees, the president of the university and Dr. A. P. Carman, professor of physics. At a subsequent session addresses will be made by Professor David Kinley, dean of the graduate school and Professor Arthur G. Webster, of Clark University. On November 27, the American Physical Society will hold its regular meeting at the university.

THE formal inauguration of Dr. Edmund C. Sanford as president of Clark College will be held on founder's day, February 1, 1910.

PROFESSOR CLARENCE E. REID, who for the last four years has been assistant professor of electrical engineering at the Case School of Applied Science, has been appointed head of the department of physics and electrical engineering at the Mississippi Agricultural and Mechanical College.

DR. G. C. FRACKER has resigned the chair of philosophy and psychology at Coe College to accept the chair of psychology and education at the State Normal School of Marquette, Mich., where he succeeds Professor L. S. Anderson, who has gone to the University of Illinois. Dr. F. S. Newell has been appointed to the position in Coe College.

AT the University of Birmingham Mr. J. S. C. Douglas has been appointed lecturer in pathology and bacteriology, and Mr. Leonard Doncaster, special lecturer in heredity and variation.

MR. GORDON MERRIMAN, of Trinity Hall, has been appointed to the studentship in medical entomology at Cambridge University, lately held by Mr. F. P. Jepson, of Pembroke College.

DISCUSSION AND CORRESPONDENCE

THE COMBINED COURSE LEADING TO THE DEGREES OF A.B. OR B.S., AND OF M.D.

THE combined course leading to the degrees of A.B. or B.S. and the degree of M.D. which is discussed by Professor Christian in his address at Leland Stanford University[1] is a topic of such importance that Professor Christian's comments ought not to go unanswered. His declaration that "These schools have succeeded in rendering the A.B. degree of less value and significance than formerly and have sacrificed one or two years of college work while seeking to conceal this fact by the award of the two degrees A.B. and M.D.," will hardly be accepted as a just and truthful statement of the facts, by the twenty-five or more institutions now offering the combined course. Those persons who maintain that the bachelor's degree should be awarded only to those students who have completed the rigid, classical four years' course of study formerly prescribed, may logically object to the substitution of science work for one half or more of this curriculum, such as has been permitted in Harvard University for many years. But this rigid, classical ideal was shattered more than thirty years ago by the institution of the elective system in Harvard University—a system which in one modification or another has come to be all but universal in our American universities.

Of the right of the fundamental medical sciences, anatomy, histology, embryology, physiology, physiological chemistry, bacteriology, pharmacology and fundamental pathology—to a place in the university curriculum

[1] SCIENCE, October 22, 1909.

there can scarcely be room for discussion at this time. Says Professor Christian in another part of his address:

There is no essential difference between the methods followed by the pathologist in his investigation and those followed by the zoologist in certain of his fields of work; the medical chemist uses the procedures of the organic chemist; the bacteriologist is an investigator in a special field of botany. That in the medical departments man and his diseases is the ultimate subject of study is no reason for regarding these studies as less cultural than other university subjects.

President Eliot has put the case of the medical subjects even more forcibly. He has said:

There is no line between cultural and professional subjects. There is absolutely no line. I read the other day an admirable definition by President Hadley of what we wanted the colleges to effect, not the professional school—presumably Yale College. He said we wanted to teach the college youth civic duty and religious earnestness, and health of mind and religious aspiration; he wanted to teach him public service as the root of American life and therefore of American education. Now, that is twice as gospel, gentlemen. It is the educational gospel. But, in my judgment, it is not the gospel of the American college only, it is the gospel of American education from the primary school through the professional school, and I know of no subject better adapted to develop the sense of civic duty, of public service, and of moral and religious earnestness than the subjects taught in the medical school.

If these things be true, if we accept the elective system, and grant to those sciences which constitute the first two years of the curriculum of all medical schools the right to a place among the sciences taught in the university, can there be any logical escape from the conclusion that if a young man elects these sciences during the junior and senior years of his college course, he must be granted a bachelor's degree on the successful completion of his four years of college work?

No—the combined course has not degraded, nor lessened, the significance of the bachelor's degree. Rather I am strongly inclined to believe, it has elevated and enlarged its significance. The student whose last two years

of college work have been taken in subjects directly related to his chosen vocation, pursued with an enthusiasm and an earnestness born of a definite purpose is pretty certain to have attained to a higher degree of cultivation of his mental faculties—which is the chief end of any educational system—than is the student whose studies are not directed toward a definite purpose.

Has the combined course tended to degrade or lessen the significance of the degree of M.D.? If the requirement for admission to the medical school had been a bachelor's degree, then that charge might be justly brought against the combined course, but it is to be remembered that when this plan was first projected but a single one of the 160 or more medical schools in America exacted anything more than a high-school diploma. The Harvard Medical School and all the remainder of the list, excepting the Johns Hopkins Medical School, were on this basis. Of course two years of college preparation is not equal in value to four years, and it is in the highest degree desirable that a student should complete four years of college work, exclusive of the medical sciences, if his age and other circumstances permit him to do so. A large and an increasing number of students are meeting this higher requirement in all of the better medical schools, and every inducement should be offered to young men to complete a full college course before entering upon the study of medicine. But for a long time to come we shall have in this country a considerable number of men to whom the exaction of four years' requirement would mean deferment of their entrance upon medical study and practise beyond that age at which it is wise and best for them to begin their life work. As President Eliot has said: "If a young man takes his A.B. at twenty-two he can hardly hope to begin the practise of his profession before the age of twenty-six. That is quite late enough." Professor Christian has himself so well stated the objections to late graduation in medicine that it is perhaps unnecessary to discuss the subject further, but a specific case may serve to emphasize this point. My advice has been

sought within a few days by a young man of twenty-seven who is just entering upon his second year of college work. He is willing and anxious to pursue that course which is best for him as a preparation for medical practise. He came to inquire specifically whether he ought to complete his college course and secure his bachelor's degree before entering the medical school, or should he take up the medical subjects in the combined course next year. The first alternative would defer his entrance into actual practise eight years (including one year of hospital training), at which time he will be thirty-five years of age. He is securing in the two years of preparatory college work two majors of college physics (240 hours), four majors of college chemistry (he has had one year each of physics and chemistry in high school), one major of biology, and eleven majors of work in English, mathematics, psychology, German and French, and other non-scientific subjects. Is it wise to advise this young man to defer his graduation in medicine until he is thirty-five? If he were nineteen, twenty or twenty-one, the problem would be quite a different one. At such an age he could well afford to go the whole road. In such a case the work of the last two years in college should in most cases be along lines not related to the medical curriculum but rather in the humanities, to the end that the student may become a broadly cultured, scholarly man and citizen, as well as a thoroughly trained physician. Some additional work in chemistry—quantitative analysis—and in comparative anatomy, he should have, and especially should he carry on some piece of independent investigation in order to develop the power of accurate observation and of clear logical thinking which is the most essential qualification for the practise of medicine.

Professor Christian will be glad to learn that the hope in which he indulges " that the day will soon come when the higher degrees will be awarded for medical studies just as for other university subjects," has long since been realized. The day arrived some years ago when courses in anatomy, physiology, pharmacology, bacteriology, pathology and experimental medicine were made in the most complete sense university courses, in the University of Chicago. For over five years it has been possible for the graduate students in this university to secure the doctorate degree for research in any of these departments, and several Ph.D. degrees have been so conferred. I believe the same conditions obtain at the universities of Wisconsin, Nebraska, Kansas, California and other western institutions, in which institutions such departments have been organized in the university proper, where they rightly belong.

JOHN M. DODSON

SCHOLASTIC COMPETITION

THE earnestness and enthusiasm which competition has given to athletics invites serious consideration, as to how a similar competitive spirit may be stimulated in collegiate studies. The fixed standard serves to eliminate the lazy and stupid students, and requires a certain activity of the general mass; but does nothing to make the best men put forth their full powers.

Such prizes as have generally been offered, namely, medals, books or money, do not fire the imagination of a scholar, nor make his fellows cheer him. They are seldom worthy objects of prolonged mental discipline and self-denial. Further, the basis of their award is often so one-sided as to diminish their value in the eyes of students. It is power which should be stimulated and rewarded rather than a cut-and-dried record.

The value of the moments of great dramatic action in athletics has been recognized and is used as a stimulus for the prolonged and tedious training. From the nature of scholastic studies, these dramatic moments are fewer, but should therefore be made much of and multiplied where possible.

In a very few colleges there is a class of rewards which really stimulate the best scholars and enthuse their fellow students. While varying in different institutions and departments, they are always opportunities for widening the experience and increasing the knowledge of the successful competitors. I

refer especially to the expeditions sent out for collecting and study; a two-months' trip from a Massachusetts college to Cuba to make a geological collection, or from an Ohio college to the Maine coast for an anthropological collection, offers two or three of the best men an opportunity for broadening experience and further first-hand study; which is a fit reward for excellency in geology or archeology; and the men respond to it.

Of necessity the plans of such an expedition, when they are to serve as a stimulus to scholarship, must be carefully thought through. The membership must be limited to men who have earned the right. The field should be distant enough to be a new experience. The objects of the expedition must be broad enough to interest not only those who go, but their fellow students. The manner of life should be as untrammeled as practicable, camping if possible. In general, research work would be too technical for the main object of such an expedition; but it is rare indeed that two months of active work by a party of three or four fails to bring to light some new form, or make some concrete contribution to knowledge. And it is this possibility, like the vein of gold to the prospector, which urges the men ever on; and upon their return, it is the account of this success which brings the cheers of their fellows. This last is a very important part of an expedition, being the dramatic moment which completes the trip.

While such natural sciences as anthropology, biology, botany, geology and zoology most easily lend themselves to expeditions, other departments like economics, physics, chemistry, etc., can use them for study and accumulation of data if not for collecting. Languages and mathematics will find methods along different lines. But I believe that in all cases the prize which will stimulate the best scholastic work is to offer the successful competitors a broader opportunity, and an experience which will probably not come to him again in later life. It is a taste of the fruit which mature work in his field offers.

<div align="right">F. B. Loomis</div>

Amherst College

HISTORICAL GRAPHICS

To the Editor of Science: The two recent letters in Science with the above title suggest the hope that many other teachers are presenting the personal and historical sides of their subjects along with the scientific and formal parts, and are using charts like those described. It would be well worth the time needed, to require students to make such charts for different subjects, suitable brief lists of names with dates being furnished them and proper scales being suggested. It is obvious that where it is important to note contemporary lives—as in studying Italian art, or the wars between England and France, or between the kings of Judah and Israel—such charts are practically indispensable. If it is desired to unite in one chart both duration, as of lives, and dates of events, it is sometimes better to put the time in a vertical column.

But do not let it be overlooked that we owe this ingenious device to the famous Dr. Joseph Priestley, F.R.S., the chemist, historian, political writer and theologian. In 1765 he published " A Chart of Biography" which ran through many editions, including one at Philadelphia in 1803. A similar idea was utilized in " A New Chart of History" in 1770, of which a fifteenth edition appeared in 1816. His " Lectures on History," 1788, and several times reprinted, are accompanied by a small specimen of each chart. In one place he says:

> The state of the world with respect to persons . . . may be exhibited with ease and advantage by means of *lines* and *spaces*. . . . Our idea of *time* is always that of a *line*.

The advantages are set forth at length. His original chart covered the period 1200 B.C. to about 1750 A.D. and had 2,000 names divided into classes, with dates and areas; durations that were certain were represented by full lines; uncertain periods by dotted lines. These principles were clearly applied in the " Biographical Chart " with fifty names prefixed to his voluminous " History and Present State of Vision, Light and Colors," 1772.

As Americans we have a special interest in the man, because of his association with Ben-

jamin Franklin, who suggested that he write a history of electricity and to whom he dedicated his " Description of a Chart of History," and because the later years of his life were spent in Pennsylvania.

CHARLES K. WEAD

THE ZIA MESA AND RUINS

In Mr. Edgar L. Hewett's " Antiquities of the Jemez Plateau, New Mexico," page 45, the description of village No. 41 reads:

On a partially isolated bit of mesa about three miles west of Jemez is a considerable ruin, which does not bear evidence, however, of long occupancy. The summit of the mesa is without trees and almost without soil, and water must have been obtained from below. The walls of the ruin are well defined, and stand in place five or six feet in height; but they are formed of rough, loosely laid stones, and are extremely thin and unstable. They could not have been high at any time, as there is a marked absence of débris, and the dearth of pottery and kitchen refuse would seem to stamp the place as a temporary or emergency abode. The site is favorable for defense, and there are traces of defensive walls along the margin and the summit. The buildings are irregular in plan and comprise three groups, the full length of the groups being about 450 feet and width 350. . . . There appears to be no definite historic reference to this site.[1]

I wish to call attention to the last sentence quoted:

The archives at Santa Fé state that when Diego de Vargas Zapata Lujan Ponce de Leon, governor of El Paso and the Northern Province, made his first entrada northward in 1692 he found that the Zias and Santa Annas together had built a new village on Mesa Colorado (Red Mesa) and the Jemez, Santo Domingo and a few Apaches were fortified on the other mesa at the forks of the river. The Zias readily submitted but the Jemez were hostile. Their place submitted finally, October 26, 1692.[2]

Also when bringing the hostile pueblos under

subjugation, Governor Vargas with 120 men joined the Queres under Chief Ojeda in an attack on the Jemez on July 21, 1694. While en route the Zia Mesa (Mesa Colorado) was captured, five men being killed. Then on July 24 they took the Jemez mesa-pueblo, called Mesa Don Diego. The fight here was one of the fiercest fought, the Queres did much in securing the place. Here Don Eusebio de Vargas, brother of the governor, distinguished himself. The Jemez lost 81 killed, 371 prisoners, the village was sacked and burned, 300 *fanegas* of corn were captured. The Jemez governor, Chief Diego, was surrendered, first condemned to be shot, but finally sent as a slave to the mines of Nueva Vizcaya; the Indians surrendered him, it is stated, saying that he had been the cause of the trouble. The prisoners, in part, were allowed to go back to Jemez and build on the old site in the valley, if they would promise to aid in the wars when needed. Their wives and children were kept as hostages till after the capture of San Ildefonso, which was then still holding out against the Spanish authority.[3]

The village on Mesa Colorado referred to in the archives is undoubtedly the ruin No. 41, mentioned by Mr. Hewett and also by Mr. Holmes. The writer has often visited the mesa and village in question. The rocks of the mesa are almost blood red in color, so red that even the walls of the writer's office in the Jemez village three miles distant were caused to have a reddish glow from the reflected sunlight in the early morning hours. There is no other mesa in the vicinity on which a village-ruin is situated, except the one at the forks of the river on which the old Jemez village was located. Furthermore, the Jemez people call the Red Mesa the Zia Mesa to-day; and the Zias themselves say that their people once lived on it. The ruin on it, I reassert, is undoubtedly the Zia pueblo on Mesa Colorado mentioned in the Spanish records.

Note.—In all the archeological notes on the Jemez region there seems to be no mention of the remains of an ancient reservoir back of the white buttes at the mouth of a canyada that comes down from the foothills and enters the valley-flat adjacent to the Zia Mesa. This reservoir doubtless supplied the village with water for drinking purposes at times.

[1] Smithsonian Institution, Bureau of American Ethnology, Bulletin 32, pp. 45–6. Also see " Notes on the Jemez Valley, New Mexico," by W. H. Holmes, *American Anthropologist*, Vol. I., No. 2, April–June, 1905.

[2] Also see Bancroft's " History," the volume on New Mexico and Arizona.

[3] " Archives, New Mexico," 158–162.

Also no reference seems to be made of the ancient irrigating ditch that now skirts the bluffs east of the Jemez River, some twenty-five feet above the present ditch. Also no mention has ever been made of the petroglyphs on "red rock" in the valley about a mile north of the present village of Jemez. Here are drawings of deer, lightnings, snakes, the sun and moon, Montezuma and the footprints of "the great road-runner."

Albert B. Reagan

Nett Lake School,
Orr, Minn.

MAP OF MASSACHUSETTS WANTED

To the Editor of Science: The U. S. Geological Survey published in 1889 a four sheet map of Massachusetts and Rhode Island, scale $\frac{1}{250000}$ contour interval 100 feet, forming a sheet 48×30 inches, and engraved by Julius Bien. Any person possessing a copy of this map and willing to loan the same for a short time would confer a great favor by communicating with the subscriber.

B. K. Emerson

Amherst College

THE BERKELEY ASTRONOMICAL DEPARTMENT

To the Editor of Science: It has recently come to the attention of the Berkeley astronomical department of the University of California that Dr. See's reference to it (p. 479 of the issue of Science of Oct. 8, 1909) has created an erroneous impression concerning the connection of the department with his recent theories of cosmogony. This note is to point out that the Berkeley astronomical department has, in no way, either approved or disapproved them. Its attitude has been entirely neutral, as is evidenced by several newspaper interviews, in which it has always been definitely stated that the department would be in no position either to affirm or to refute any of Dr. See's theories until the completed work becomes available. This completed work has not yet appeared.

It is to be added that from June, 1908 until August, 1909, Professor Leuschner, director of the students' observatory of this department, was abroad on leave and that the writer, as acting director, is entirely responsible for all matters emanating from here during that interval.

R. T. Crawford

Berkeley Astronomical Department,
University of California,
November 6, 1909

SCIENTIFIC BOOKS

Foundations of American Grape Culture. By T. V. Munson, D.Sc. Denison, Texas, T. V. Munson & Son. 1909.

The colossal work of Dr. Hedrick and associates of the Geneva (N. Y.) Agricultural Experiment Station (already reviewed in Science)[1] has been of inestimable service in furnishing a ready means of identification of grape varieties under cultivation, by means of superb colored illustrations and detailed descriptive matter. That volume is mainly devoted to results of tests and observations at the station on a very wide range of cultivated varieties, and does not assume to discuss botanical relations or the subject of interbreeding, except as standards of reference.

Those who have for many years watched the determined, painstaking labors of Dr. Munson, in Texas, have anticipated pleasure and profit from the monument he was expected to erect in the form of a book recording the outcome of his patient work and great sacrifices to compass the production of advanced types of grapes in the arduous process of breeding for quality.

"Foundations of American Grape Culture" comes as a veritable boon to many who owe its author much for previous aid and encouragement in the tedious and unremunerative practise of grape breeding. It is so filled with meat, so well and compactly arranged and thoroughly indexed, so copiously illustrated with most excellent reproductions from life, and so thoroughly digested, that it is impossible to characterize its contents in a sentence. The volume is remarkable in breadth of scope, completeness of treatment and wealth of detail, yet in clearness, conciseness

[1] "The Grapes of New York."

and effective generalization it is no less conspicuous. The botanist, culturist and interbreeder will each and all find the latest word from an adequate authority whose conclusions are convincingly stated with all the evidence in plain view. The value of the conclusions, aside from the high reputation of the author, is made manifest by a vast accumulation of facts well classified in the text, and by 86 full-page half-tones from nature photographs and other appropriate illustrations.

These reproductions of seed, wood, leaf, flower and fruit, executed with consummate skill of photographer and printer, under the jealous scrutiny of Dr. Munson, are far beyond anything heretofore brought out in black and white in this line.

Preceded by a choice portrait of the author, as a frontispiece, followed by a dedication in form of an original poem, the preface states succinctly the reasons which necessitate founding American grape culture upon the native species as a base. A modest review of the author's lifetime work in this field, a clear statement of the ideals to be sought in the compounding of strains and a list of vineyards and nurseries used as experimental grounds during more than thirty years of observation, culture and breeding, fill out the introductory pages.

Chapter I., of 101 pages, on the Botany of American Grapes, is replete with information, and constitutes a contribution of great importance to science. This has the merit of presenting a very complex subject, not without autocratic decisions, but always with clear indication of the facts which justify such conclusions in the author's mind. Dr. Munson's observations have been more wide-spread and continuous, his studies more profound and his methods more precise than other investigators in this field. His revised scheme of classification here published may therefore be taken with confidence for just what he regards it— an attempt to arrange the species of grapes in a scheme of classification which shall, as nearly as possible, group them in accordance with natural relationships, that is to say, "in approximate chronological order of development," the unknown "chronology and actual

genealogy" being inferred from similarities in form and especially from biological similarities. As such, this is a decided advance in systematic botany, although it is confessedly and approximately framed primarily for the guidance of practical culturists instead of philosophic students.

In this chapter the 28 species allowed (26 American, 2 foreign) are carefully described in minute detail, by botanical characters, with typical full-page illustrations, followed in each instance by very full "Viticultural Observations and Remarks," giving a vast amount of information regarding growth from seed and cuttings, foliation, inflorescence, resistance to disease, natural and artificial crosses and hybrids.

Chapter II., Breeding of Varieties of Grapes, covers 27 pages of valuable discussion on thoroughbred vines, selection of parents, order of germination, blooming periods, length of life, soil adaptability, climatic range, longevity, market value, analyses of fruit, graft stocks, selections of varieties for breeding north and south, for wine or table use, description of ideal variety, directions for crossing and hybridizing, collecting and preserving pollen, labeling seeds, planting seeds, care of seed-beds, transplanting, nursery treatment, and much valuable suggestion concerning allied subjects. Several tables of great interest are interspersed, making this chapter a most profitable mine of information of original character.

Chapter III., of 74 pages, arranges alphabetically by mother species the prominent varieties of grapes, discussing each very fully by descriptive text and full-page illustrations, showing the pedigree clearly and all details of origin, constitution and other information needed by growers.

Chapter IV., Adaptation of Varieties, treats of resistance to cold, heat, wet, drouth, soils, insects, fungi, followed by Select Lists of Varieties for Various Regions, giving a complete outline of distribution in eight zones. Of this arrangement, Dr. Munson justly remarks: "It is the opinion of the writer that this chapter is one of the most valuable pieces of grape literature ever presented to the prac-

tical grape-growers of the United States." At the close of the chapter is given a list of some of the best tested resistant graft stocks.

Four more meaty chapters on Practical Grape Growing are condensed in 24 pages. Chapter V. treats well of culture from the seed to fruiting, including selection and preparation of soil, choice of varieties, planting, trellising, pruning and training, fertilization, etc. Chapter VI., on Protection from Insects and Fungi, discusses preventive measures, including grafting on resistant stocks, spraying and other remedies, with brief descriptions of enemies to the vine. Chapter VII. is short and crisp, dealing with marketing of the crop, only touching on wine and brandy, but giving some space to the manufacture of grape juice, raisins, jams and jellies. Chapter VIII. gives important hints on the selection and treatment of vines for fruit, adornment and other home uses.

In the matter of indices, often lacking or deficient in works of this class, the author merits high commendation. He has placed at the close of the volume no less than five adequate synopses, as follows: (1) List of Illustrations, with 97 entries, italics being used to designate plates of specific types; (2) Synopsis of Chapters, a complete table of contents, itemized fully; (3) Index of Species and Varieties (211, in all, described in the work); (4) Index of Topics, a general index, exclusive of species and varieties; (5) List of Tables. There are ten of these, segregating statistics of importance, chiefly original with the author.

Thus compressed in 252 pages 7½ inches by 10½ inches, in a well-bound volume, with clear sharp type impressed on good heavy paper, the well-known author has met his eager public in most commendable dress. This outcome of his zeal and patience, measured from any view-point, must long be regarded as a model of its kind. Every new experimenter with grapes is set a quarter century ahead by the knowledge here vouchsafed, and the record of the author's achievement must serve as inspiration to a host of earnest students in the same field. The book brings into clear perspective for the first time the full measure of the scientific work of Dr. Munson. Its influence upon the development of viticulture the world over will be felt even more strongly by future generations.

Theo. B. Comstock

Los Angeles, Cal.

Exercise in Education and Medicine. By R. Tait McKenzie, A.B., M.D., Professor of Physical Education, and Director of the Department, University of Pennsylvania. Octavo of 406 pages, with 346 illustrations. Philadelphia and London, W. B. Saunders Company. 1909. Cloth, $3.50 net; half morocco, $5.00 net.

This book represents a distinct advance in the literature on physical exercise. It is well written, and interesting. It contains a good deal of material of scientific value. The various chapters are well supplied with first-class illustrations, some of which are from the author's own work. McKenzie's high rank as a sculptor is shown in the artistic features of these cuts. The text contains numerous references to the sources from which the author draws material. These references are ample for the general reader, though not sufficiently explicit for the investigating student.

The contents of the book are as follows:

Part I.: Exercise in Education—Chapter I., The Definition and Classification of Exercise; Chapter II., The Physiology of Exercise; Chapter III., Massage and Passive Motion; Chapter IV., Exercise by Apparatus; Chapter V., The German System of Physical Training; Chapter VI., The Swedish System of Gymnastics; Chapter VII., The Soft Business of Japan; Chapter VIII., Age, Sex and Occupation; Chapter IX., Playgrounds and Municipal Gymnasiums; Chapter X., Physical Education in Schools; Chapter XI., Physical Education in the College and University; Chapter XII., The Physical Education of the Blind, and Deaf Mute; Chapter XIII., Physical Education of Mental and Moral Defectives.

Part II.: Exercise in Medicine—Chapter I., The Application of Exercise to Pathogenic Conditions; Chapter II., Flat-foot and its Treatment; Chapter III., The Cause and

Treatment of Round Back, Stooped and Uneven Shoulders; Chapter IV., Scoliosis, its Causes, Varieties, Diagnosis and Prognosis; Chapter V., The Treatment of Scoliosis; Chapter VI., Exercise and Athletics as a Factor in Disease of the Circulation; Chapter VII., Obesity—its Cause and Treatment; Chapter VIII., Other Diseases of Nutrition; Chapter IX., Exercise in the Treatment of Nervous Diseases; Chapter X., The Treatment of Locomotor Ataxia by Exercise.

In reading the preface and looking over the table of contents one is struck with the fact that the author has planned to reach a wide range of readers, and for that reason has brought together a variety of material that is not usually so associated. He states in the preface that "the following pages are addressed to students and practitioners of physical training; to teachers of the youth; to students of medicine and to its practitioners, with the purpose to give a comprehensive view of the space exercise should hold in a complete scheme of education and in the treatment of abnormal or diseased conditions." A single text must be popularly written if it is planned for the student and practitioner of physical training; the teacher of the youth; and for the student and practitioner of medicine. The technicality of the average medical treatise is unintelligible to the average teacher of the youth or student or practitioner of physical training, and the usual presentation of the principles and practise of physical training contains more or less that is technical to all but the student and practitioner of physical training. Dr. McKenzie has succeeded in presenting Part I., Exercise in Education, with but little technicality, and Part II., Exercise in Medicine, with only moderate technicality. The book, therefore, is a popular book. It is, also, to some degree, a reference book.

On page 33 it is stated that " . . . in every course of athletic training the blood is still further thickened by restricting the amount of fluid ingested to replace evaporation." Dr. McKenzie takes the position that "condition" is the result of a "drying out" of the tissues and a thickening of the blood. This is the point of view of the trainer, but it is a deduction which is hardly justified scientifically. It is true that exercise increases the specific gravity of the blood somewhat, but so does sleep. The ingestion of food and the progress of the day decreases the specific gravity. One can hardly draw relevant conclusions from such data. Furthermore, the present tendency on the part of trainers is to break away from strict water restrictions and the success of those trainers has been as great as under the so-called tissue-drying process.

Page 35, "milometers" should read "millimeters" (mercury).

The reasons assigned for blood pressure changes in the chapter on The Physiology of Exercise are almost entirely mechanical. The influences of the vaso-motor reflexes seem not to have been considered.

Page 39, " . . . in fatigue, the will tires long before the contracting power of the muscle is lost." Lee states that "the former and still common idea that the brain and spinal cord are readily fatiguable, and in fact are the first part of the individual to succumb in a contest, seems not to be justified by the experiments of Hough, Storey, Woodworth, Joleyko, Kraepelin and others."[1]

Page 42, "The men were then wrapped in blankets . . . and showed a further loss (in weight). In no case was any gain found." Dr. McKenzie should have given his series of experiments a fuller consideration. There is back of the sentence "in no case was any gain found," an interesting discussion and investigation of the question as to the possibility of a gain in weight from inspired oxygen after extreme losses in weight during strenuous exercise.

Pages 126 and 129. A reference or an account of the researches on which the results are based should accompany the very interesting and valuable tables classifying athletic games and exercise, and giving their influence on blood pressure.

[1] "Physical Exercise from the Standpoint of Physiology," Frederic S. Lee, *Amer. Physical Educ. Review*, April, 1909, p. 5.

Page 142. The sand box is recommended for playgrounds. I think there is no other single feature that figures in the equipment of a playground that even approaches the sand box in its unhygienic, bacteriological and parasitic possibilities.

Page 167. Dr. McKenzie advises the use of floor sockets for fixing apparatus like the horse, parallel and horizontal bars on the floor of the exercising hall. It is only fair to state that a number of men have found or judged this device to be less convenient and utilitarian than the old movable apparatus. The experience at Pennsylvania, however, has been satisfactory.

Page 191. It is stated that summer courses in physical instruction are given at the College of the City of New York. This is a mistake.

Part II., Exercise in Medicine, contains much that interests the non-medical reader. It is rather too popular and brief for the specialist or general practitioner concerned with the various diseases discussed. It contains very little which the "teacher of the youth" would be expected to apply. The average "student and the practitioner of physical training" who has had no medical experience should not attempt the treatment of medical cases unless under the direction of a competent physician. "Round back and stooped and uneven shoulders" are not necessarily medical; but scoliosis and locomotor ataxia are samples of abnormal conditions which the non-medical man would do well to leave alone—unless he has a training and an experience like that of Bolin.

But I take it Dr. McKenzie has not attempted to prepare a text-book for such readers, but rather to present a discussion which will show them the relation of exercise to the treatment of various diseases so that they may secure an intelligent sympathy for the logical and common-sense principles which he has brought together.

In conclusion it may be said that in its "purpose to give a comprehensive view of the space exercise should hold in a complete scheme of education and in the treatment of abnormal or diseased conditions," this book is a success.   Thomas A. Storey

Second Appendix to the Sixth Edition of Dana's System of Mineralogy. By Edward S. Dana and William E. Ford. New York, John Wiley & Sons. 1909.

Dana's "System of Mineralogy," as a standard work of reference, has become so indispensable to every one interested in minerals that all additions to it, which tend to bring the work up to date, will always be welcomed. Ten years have elapsed since the first appendix appeared and this period has been one of great activity in mineralogical research. Many new mineral names have been proposed, and new occurrences, forms and physical properties of known species have been described. This second appendix contains an excellent bibliography of mineralogical literature issued during the ten years with a concise statement of the subject matter of each article and quotation of new forms, and complete descriptions of all minerals that have been announced as new species; consequently references to several hundred minerals are included in the book. Over two hundred new names have been proposed for minerals and from this number the authors have selected about sixty, on account of their better descriptions, as meriting the distinction of being new species. As to this limited selection from so many new compounds, some disagreement with the authors may arise, but they feel justified in relegating to subordinate rank most of the so-called new minerals, because of the insufficient data to establish their recognition as species.

The appendix is similar in size, binding and arrangement of contents to the first one, issued in 1899. The minerals are arranged in alphabetical order with all of the new names in heavy-faced type, but in the classified list only those considered as new species are in bold type. The great task of preparing this appendix was begun by the senior author and continued by him until 1906 when his health compelled him to give up the work, and it devolved upon the junior author to complete the book to the present year, which he has ably done.

Every scientific investigator will deeply regret the loss of Professor Dana from active work, and it is the heart-felt wish of his legion of friends that he may speedily regain his health and strength. With his retirement, and

the lamentable departure of his brilliant colleague, the late Professor Penfield, mineralogical science has lost two of its foremost and ablest promoters.

ARTHUR S. EAKLE

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SCIENTIFIC JOURNALS AND ARTICLES

Journal of Economic Entomology, Vol. I., February, 1908–December, 1908; Vol. II., February, 1909–December, 1909.

It is not often that it is possible to write a review of a periodical with its numerous contributions of varying merit, and it is possible in this case only because it is a growth and illustrates the growth of a science and its development along practical lines. It is stated on the cover that this is the official organ of the Association of Economic Entomologists, and any note of the *Journal* must contain some record of this association.

It was at Toronto, in August, 1889, that the Association of Economic Entomologists was born at the call of the late Dr. James Fletcher, with the extremely limited membership of twenty-two, which elected the late Dr. C. V. Riley, then entomologist to the U. S. Department of Agriculture, as its first president, and the writer of this review as its secretary. During the twenty years following that initial gathering, the writer has been in attendance at most of the meetings, and has seen its membership increase until, under new restrictive laws, there are 119 active, 125 associate and 47 foreign members—a total of 291. More entomologists here, more or less engaged in active research work, than the wildest dreams of the founders considered possible at the initial meeting.

From the beginning, the relation of this association with the U. S. Department of Agriculture was close. Small as the entomological division of the department was at that time, compared with its present-day development, it represented to the rest of the country a source of authority and information which, in all subsequent development, has not lessened in value, even if not as dominant now as then.

Dr. Riley, as the first president of the association and one of its most active promoters, was naturally interested in securing publicity to its transactions, and reasoning rightly that any force that made for impressing upon the agricultural public the value of entomological work was worth using, he induced the then commissioner of agriculture to authorize the publication of the proceedings of the association in *Insect Life,* where the record of the organization takes up a part of pages 87 and 88 of Vol. II., and the records of the first annual meeting take up pages 177–184 of the same volume. During the continuance of *Insect Life,* an ever-increasing space was occupied by this association until, in 1893, at the fifth annual meeting, an entire number of *Insect Life,* of about 145 pages, was taken up by its records. After the discontinuance of this periodical, the records of the association were published in the bulletins of the department, and Dr. L. O. Howard, who succeeded Dr. Riley as head of the entomological division, followed the policy of his former chief in recommending the publication of the proceedings of the association by the department.

But, as the membership increased and as, to speak metaphorically, the association felt its oats, the tendency was to divorce the association, loosely constituted as it was and in no position to assume publication, from the department and to throw it upon its own resources. It solved the problem of support for the proposed journal by the organization of a publishing company which assumed financial responsibility, while the association furnished material to be published, as well as the subscribers.

The writer was one of the conservative members who, by age and long habit, was wedded to past methods, and who opposed the establishment of the *Journal of Economic Entomology.* It gives him pleasure to admit that he was all wrong; that the establishment of the *Journal* was justified by results, and that the cause of economic entomology was materially advanced by the action of the association in 1908.

The *Journal of Economic Entomology* under the editorship of Dr. E. Porter Felt, of Albany, N. Y., and under the business management of Professor E. D. Sanderson, of Durham, N. H., has been a power for the development of economic entomology. It has not only published the records of the meetings of Chicago in 1907, and at Baltimore in 1908, but it has secured for economic workers throughout the country, records of progress throughout the season, and it has made possible the early publication of results that were of sufficient importance to warrant the attention of other workers along similar lines. It would be easy to criticize adversely individual publications in this journal, and to find fault with details of management, but in that it would share only the fate of other periodicals that depend upon individuals for their contents. The *Journal of Economic Entomolcgy* has not only justified itself during the nearly two years of its existence; but, in the opinion of one of its opponents, has done excellent work in the advancement of the science whose records it publishes.   John B. Smith

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SPECIAL ARTICLES

ON THE PLANT GEOGRAPHY OF THE CHIRICAHUA MOUNTAINS

The Chiricahua Mountains[1] of southeastern Arizona extend almost due north and south for some 50 miles from Fort Bowie to a point near College Peak, and within 15 miles of the Mexican Boundary, with a maximum width at Paradise of 18 miles. On their west lies the broad and level Sulphur Springs Valley at about 5,000 feet altitude, on their east the trough-like San Simon Valley drops to nearly 3,500 feet. The highest part of the range extends from Paradise to Rucker Canyon, consists of five or six more or less elongated forest-covered peaks whose axes lie in a north-

[1] In 1906 and 1907, ten months were given to the exploration of this range, some 1,600 miles covered within its bounds, and about 1,050 species of plants collected. Undoubtedly many other higher plants may be found.

east-southwest direction, and rises in Cave Peak to an altitude of about 9,700 feet above sea-level.

As one might expect, the tree growth is quite similar to that recently given by Mearns[2] for several mountain ranges near the international boundary of this region. Of the 54 species (including a few shrubs) mentioned as occurring about 12 or 15 mountain masses of his "Elevated Central Tract," 48 are found in the Chiricahuas alone. He enumerates 137 arborescent species along the boundary from Texas to the Pacific Coast. In the Chiricahuas were found, exclusive of succulents and Liliaceæ, a total of 124 species of trees and shrubs. These consist of 111 angiosperms and 13 gymnosperms, all the latter being trees except *Ephedra* sp., and all evergreen. Of the angiosperms, 35 are trees and 76 are shrubs, making a total for the mountains of 47 trees and 77 shrubs. Ten of the latter are suffrutescent composites, probably all more or less evergreen, at least when sufficient moisture is available. Of the remaining shrubby species, 39 are deciduous and 16 evergreen, while 12 in this respect are unknown to the writer. Thus the total of known evergreens is 47, that of deciduous species, 65. Other species will be found, but they will probably not materially alter these proportions.

This does not, however, give the key to a true, general picture of the floral geography. This must rather base upon the number, size and distribution of the individuals composing the more prevalent species. From this viewpoint, leaving out of consideration the winter-dead ground-cover of perennial and annual grasses and herbs, the evergreen character is altogether dominant. The Lower Sonoran zone, characterized by its cacti and thorny shrubs, often drouth-deciduous, touches the mountains only at their eastern base and both ends. The Upper Sonoran completely encircles them in a broad belt of evergreen brush land, with the oaks as leading species, corresponding to one of the types of Schimper's Immergrünes Hartlaubgehölze. This extends well into the Transition zone, and here mingles with the

[2] "Mammals of the Mex. Bound. of the U. S.," Part I., Bull. 56, U. S. Nat. Mus., 1907.

outposts of the tall coniferous forest, which through the Canadian and Hudsonian zones envelops all the remainder of the range with a mantle of needle-leaf evergreen differing only in its much deeper hue from the light green of the largely sclerophyllous broadleaf brush-woods of the lower slopes.

The larger species most characteristic of the several zones are as follows: Lower Sonoran or Desert Zone—*Acacia constricta* Benth., *A. greggii* A. Gray, *Prosopis velutina* Wooton.[3] Upper Sonoran or Oak Zone—*Quercus oblongifolia* Torr., *Q. emoryi* Torr., *Q. toumeyi* Sarg., *Juniperus monosperma* Engelm., *Prosopis glandulosa* Torr.[3] Transition or Pine Zone—*Pinus chihuahuana* Engelm., *P. mayriana* Sudw., *P. cembroides* Zucc., *Quercus hypoleuca* Engelm., *Q. reticulata* H. B. K. Canadian or Fir Zone—*Abies concolor* (Gord.) Parry, *Pinus arizonica* Engelm. Hudsonian or Spruce Zone—*Picea Engelmannii* (Parry) Engelm.

Other prominent species are *Quercus arizonica* Sarg. and *Juniperus pachyphlœa* Torr., which are practically coextensive throughout the Upper Sonoran and Transition zones. In like manner, *Pinus strobiformis* Engelm. links and extends over the Canadian and Hudsonian zones, becoming increasingly abundant toward the summits, while *Pseudotsuga taxifolia* (Lam.) Britton is present here and downward, reaching the remarkably low altitude of 6,500 feet on residual north slopes in several instances.

If three maps were to be drawn of this mountain range, to show the three chief features of its floral geography, the first would give the several altitudinal zones, both in succession and relative limits somewhat as outlined by Merriam for San Francisco Peak in northern Arizona.[4] The chief differences between the two mountain masses are: (1) The absence of the two uppermost zones of Merriam from the Chiricahuas, due to insufficient elevation. (2) The absence in the San Francisco Mountains of the evergreen oaks,

[3] Often considered varieties of *Prosopis juliflora* (Sw.) DC.

[4] North American Fauna No. 3, U. S. Dept. Agr., pp. 7–17, 1890.

whereas in the Chiricahuas the pinyon of the former is to a great extent replaced by oak, and should be designated the oak zone or oak-pinyon zone.

TABLE OF ALTITUDES

Zones of San Francisco Mts. (Merriam)

Desert Area	4,000–6,000 feet
Pinyon Zone	6,000–7,000 feet
Pine Zone	7,000–8,200 feet
Balsam Fir Zone	8,200–9,200 feet
Spruce Zone	9,200–10,500 feet
Timber-Line Zone	10,500–11,500 feet
Alpine Zone	Above 11,500 feet

Zones of Chiricahua Mts.

Desert Area	Below 4,500 feet
Oak Zone	4,500–6,000 feet
Pine Zone	6,000–7,900 feet
Fir Zone	7,900–8,900 feet
Spruce Zone	Above 8,900 feet

The San Francisco altitudes represent mean elevations of the limits of the several zones. The lower limits of the Chiricahua zones are approximate averages of the lowest points of extension on residual slopes of the species or groups of species for which the respective zones are named.[5] The upper limits, as given, merely coincide with the lower limits of the next higher zones. This will partly account for the lower elevation of the Chiricahua zones, while in part it may be due to lower base level (smaller land mass)[6] despite the counteractive effect of lower latitude. The zones in reality overlap, but on paper we have thus at least their true lower limits. Their upper limits fall into other zones or else are not reached. For example, the four or five larger pines extend from a limit of 6,000 feet to the ultimate summits of the range, on sunny aspects covering both the fir and the spruce zones completely. In order to admit the latter two, the former must be restricted. Similarly the oak zone, equivalent to the lower portion of the total oak area and devoid

[5] These altitudes were obtained by aneroid loaned by the Desert Laboratory of the Carnegie Institution, frequently checked by the new bench marks of the U. S. Geological Survey.

[6] See Lowell, *Century Magazine*, March, 1908.

of the larger pines, remains not always below 6,000 feet, nor the desert area below 4,500, but, under favorable (or unfavorable!)[7] conditions they may raise long tongues into the upper zones. Thus near Paradise certain points carry the former to a height of 8,700, the latter to 6,250 feet, mainly dependent upon aspect (slope exposure) modified by gradient,[8] and secondarily upon character of the rock and soil and other conditions. Also, in fixing the lower limits at their first appearance on residual slopes, we avoid the mere fringes of species that normally belong to higher zones, but follow the canyons and watercourses down and often far out into desert and grassy plain.

The second map, showing the vegetation as governed by aspect, would have the appearance of a veritable crazy-quilt in its patchwork of many small areas of different color. By far the larger part of the montane area is composed of slopes facing either north, east, south or west, or in intermediate directions. Given the same altitude, locality, rock and soil, each aspect supports a plant society differing in some degree from those of other aspects. The difference may consist in kind, number or relative proportion of species, or merely in number, relative abundance, size and thrift of individuals, usually two or more of these combined. In view of many other influences that may be at work, such as seepage, exposure to local atmospheric currents, number and size of boulders present, physical constitution and relative abundance of rock and soil, presence of animals or insects, the greatest caution is constantly necessary in attributing the differences to the proper controlling cause. However, it may be stated that, given otherwise similar conditions, the more directly one slope faces southward, and the other northward, the greater is the difference between their plant societies.

The floral difference between two small contiguous slopes of equal gradient and similar limestone soil at 5,500 feet near Paradise,[9]

[7] Spalding, *Plant World*, XI., p. 213, 1908.

[8] See Merriam, N. A. Fauna No. 3, p. 27, Pl. II.

[9] Designated as Slopes I and III in exsiccati distributed.

directly facing each other, one north, the other south, may serve as a simple example of the influence of aspect: The north slope supports a dense, shrubby growth of *Ceanothus greggii* A. Gray, interspersed with *Cercocarpus breviflorus* A. Gray, *Viguiera helianthoides* H. B. K., and numerous smaller plants, from which grasses are practically absent. The south slope is entirely devoid of trees and shrubs, dotted with *Croton corymbulosus* Engelm. and covered with grasses, among which no less than three species of *Triodia* are prominent.

These slopes for the greater part are rather sharply bounded by adjoining and opposing slopes and canyon bottoms. But, unlike the more or less insensible transition between one altitudinal zone and another, the tension lines between adjoining plant societies follow these topographic boundaries, such as crests of ridges, angles of V-shaped gullies, or sides of canyon bottoms, and usually their degree of definiteness is in direct proportion to the sharpness by which such boundaries are marked.

The third map would divide the mountains, without regard either to altitude or to aspect, into more or less irregular areas both large and small, their number dependent upon the degree of intensity employed, based upon the geologic origin and character of the rock and soil. The following main divisions may be made:

I. Transported Soils.

II. Residual Soils derived from

1. Limestone.
2. Recent eruptives.
3. Other rocks.

The small total area of transported soils is confined to outwash slopes, canyon bottoms, and small mountain parks. They support floral elements either quite peculiar to themselves, or else derived from two or more residual societies. For the present are made only the three divisions of residual soils that show the greatest differences between their plant societies as indicated by their trees and shrubs. Each division or group of societies is found to be peculiar to a class of rocks and residual soils of its own. Further, the so-called tension lines between these societies or groups of

such are usually marked with great definiteness and bear no relation to aspect. Moreover, these sharp boundary lines coincide throughout with the more plainly marked surface contacts and boundaries of such geologic formations. Cases occur in which, if two quadrats of 1,000 square feet each were laid off, each on a separate formation,[10] but adjoining one another on one side and on the contact line, not a single woody species would be common to both quadrats, although several such might be found on either.[11-12] The first class of areas is composed of limestone, the second and smallest in total extent of basalt, and the third and by far the largest, of older igneous and metamorphic rocks, predominant among which are andesite, rhyolite, granite and quartzite.[13]

The second division is practically confined to certain volcanic outbursts in the eastern and southern parts of the range, but certain spots also occur on its west side. The comparatively recent origin of these is shown by the fact that on the rim of a former crater were found volcanic bombs in a state of excellent preservation and fragments of lava that still bore plainly the marks of former plasticity. Grasses and herbs cover these hills, but they are characterized by the almost complete absence of tree and shrub growth. The adjacent hills of andesite and rhyolite bear with the same aspect and general altitude of 5,000 feet the usual evergreen oaks and junipers. Whether comparative age of the formation is a factor or not, the cause plainly lies in the substratum.

The first division is distinguished from the great composite third mainly by species of

[10] The term " formation " is here used only with reference to rock and soil.

[11] In Europe, these definite floral boundaries have long been known to occur, and their immediate cause has been recognized. See Warming, " Pflanzengeog.," sec. ed., p. 78.

[12] MacDougal, *Plant World*, XI., p. 270, 1908.

[13] Not included in above divisions, were also found smaller bodies of volcanic tuff, and still more infrequently, sandstone and shale. For the age of some Chiricahua formations see E. T. Dumble, " Notes on Geology of S.E. Arizona," *Trans. Am. Inst. Min. Eng.*, Feb., 1901.

smaller stature and leaf surface, *i. e.*, more distinctly zerophytic chaparral character. The following collection of woody species, growing on a steep, westerly, limestone slope near Hands' Cabin at approximately 7,000 feet, may serve as a type for calcareous societies of similar situation. The species are ranked in order of abundance: 1. *Ceanothus greggii* A. Gray. 2. *Cercocarpus breviflorus* A. Gray. 3. *Rhus virens* Lindh. 4. *Garrya wrightii* Torr. 5. *Pinus cembroides* Zucc. 6. *Juniperus pachyphlœa* Torr. Below is a society of trees and shrubs typical of a habitat similar to that above in all chief particulars except rock and resultant topography and soil, which is andesitic: *Quercus arizonica* Sarg., *Q. hypoleuca* Engelm., *Q. reticulata* H. B. K., *Pinus chihuahuana* Engelm., *P. mayriana* Sudw., *Ceanothus fendleri* A. Gray, *Gymnosperma corymbosa* DC., *Juniperus pachyphlœa* Torr.

A number of fern species occur upon the limestone, very few upon the andesite, but the latter often supports a better grass cover. *Dasylirion Wheeleri* Wats., though present elsewhere, is highly characteristic of limestone, *Nolina erumpens* Wats. and *Yucca macrocarpa* (Torr.) Coville are seen at their best on non-calcareous soil. The seven species of evergreen oak are almost absolutely absent from pure limestone soil. The only oak (*Quercus pungens* Liebm.) on limestone is not evergreen, and this is never found on other rocks of the region covered.

In a notable recent paper,[14] Fernald brings out similar great contrasts between the alpine floras of northeastern America, and their direct relation to the rock and soil on which they grow. As is abundantly the case in the Chiricahuas, he finds plants that are very definitely limited to certain residual soils on slopes and table-lands, freely commingling on the mixed elements of transported soils at the foot of slopes and along the watercourses.

The ultimate causes of these distributional phenomena, apart from those controlled by altitude and aspect, thus plainly lie in the substratum. How much is due to historic determinants, and how much to physicochem-

[14] Cont. Gray Herb., Harv. Univ., N. S., XXXV., 1907.

ical factors at present operative, is not easily established, but observation points strongly toward the latter as controlling forces.

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DIKES IN THE HAMILTON SHALE NEAR CLINTON-VILLE, ONONDAGA COUNTY, NEW YORK

The presence of a few igneous intrusions in the almost undisturbed Paleozoic strata of central New York has long been known to geologists. Their extreme rarity, however, has always invested them with a peculiar interest.

Excluding the Manheim Dike near Little Falls, which lies about seventy-five miles east of Syracuse and which cuts Ordovician strata, we find that these igneous rocks may be grouped geographically into (1) those occurring in the vicinity of Ithaca and Ludlowville and (2) those occurring in the vicinity of Syracuse. In both regions the intrusions are peridotite and are mostly true dikes cutting in the first case such Upper Devonian formations as the Genesee shale and the Portage and Ithaca shales and sandstones, and in the second case cutting the Salina beds of Silurian age.

As far as the writer has been able to learn, the geologically intermediate Hamilton shale has, until now, yielded no dikes and the recent discovery of two in this formation at a locality about twelve miles southwest of Syracuse and about forty miles northeasterly from Ithaca is believed to be a matter of interest.

The dikes in question are exposed on the south wall of the Clintonville Ravine at a point approximately fifty feet above the level of the Marietta road. The more western is a fine-grained porphyritic rock resembling peridotite. What appear to be serpentine grains, produced by the alteration of olivine, protrude from the weathered surface and have the appearance of small pebbles. Another conspicuous feature is furnished by large scales of a bronzy mica. This dike has a uniform width of from seven to eight inches and is displayed for about twelve feet on the south bank of the ravine. On the north side it is obscured by talus. Its plane is vertical, while its direction

is north and south, agreeing in this latter respect with the Ithaca dikes. Wherever examined it presents a very uniform texture, is apparently free from fragments of the sedimentary rocks through which it passed, and has produced little contact metamorphism.

The second dike discovered by the writer lies about two feet and four inches to the east of the first and was not observed until the wall at this point had been cleaned. It has a width of about eight inches. Like the first dike, it is vertical and north and south in direction. It differs, however, from the first dike in being much weathered in places and in containing many shale fragments some of which have a long diameter of three inches or more.

Burnett Smith

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GUINEA PIG GRAFT-HYBRIDS

In May, 1907, I published results demonstrating, (1) that iso-engrafted ovaries in fowls subsequently exhibit a reproductive function; and (2) that such resulting offspring give evidence of a " soma " or " foster mother " influence.[1] The same year, Professor Wilhelm Magnus, of the University of Christiania, obtained similar results on a rabbit.[2]

The purpose of this note is to record results obtained on a guinea pig. November 6, 1908, the ovaries of a young guinea pig were removed and in the former site of the right ovary, the left ovary from a sister guinea pig was engrafted. The guinea pig was bred and in the latter part of July or the early part of August, 1909, gave birth to two young.[3] As all the animals were mongrels it is obvious that no conclusion regarding foster mother influence is possible.

In Science,[4] September 3, 1909, Professor Castle reports the birth of two guinea pigs from a spayed white mother carrying en-

[1] Proceedings of the society, *American Journal of Physiology*, Vol. XIX., pp. xvi–xvii, July, 1907.

[2] *Norsk magazin for laegevidenskaben*, No. 9, 1907.

[3] November 12, the operated animal gave premature birth to two more young.

[4] N. S., Vol. XXX., No. 766, pp. 312–313.

grafted ovaries from a black guinea pig and bred to a white male. He states that no evidence of foster mother influence was exhibited. Indeed no such evidence was to be expected, for (1) the markings of such hybrids are not uniform, and (2) the mating was not suitable for bringing out such influence. Had the operated pig been bred to a male of the same strain as the pig from which the engrafted ovary was obtained, then in view of my own results on fowls,[5] and Magnus's results on a rabbit,[6] characteristics in the offspring indicative of such influence might have been obtained.   C. C. GUTHRIE

PHYSIOLOGICAL LABORATORY,
  UNIVERSITY OF PITTSBURGH,
    October 9, 1909

ASTRONOMICAL AND ASTROPHYSICAL SOCIETY OF AMERICA

THE American Astronomical and Astrophysical Society held its tenth annual meeting at the Yerkes Observatory, Williams Bay, Wis., on August 19, 20 and 21. The meeting was remarkable for the large attendance and for the number and character of the papers presented. Besides a number of guests there were present Miss Calvert, Miss Bigelow, Mrs. Fleming, Miss Furness, Miss Leavitt, Miss Young, Messrs. Adams, Aitken, Barnard, Barrett, Brown, Buchanan, Burnham, Cogshall, Comstock, Curtiss, Eichelberger, Fisher, Fox, Flint, Frost, Gaertner, Hamilton, Hammond, Humphreys, Hussey, Jordan, Laves, Lee, MacMillan, Mellish, Morehouse, Moulton, Parkhurst, Payne, Peters, E. C. Pickering, Petitdidier, Petrajkis, Plaskett, J. Poor, Roe, Schlesinger, Slocum, Stebbins, Stetson, St. John, Stone, Thaw, Updegraff, D. T. Wilson and H. C. Wilson.

President Pickering, after welcoming the society to Williams Bay, referred to the loss during the last year of two of its oldest members. He said in part: "Professor Newcomb, president of our society for six years, always took the greatest interest in its growth and welfare. It rarely happens that a man is really distinguished in more than one department of science. We all know his preeminence in astronomy. He used to say, 'I am not a mathematician,' yet the Mathematical Society in the strongest terms proclaimed

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[5] *Journal of Experimental Zoology*, Vol. 5, p. 563, June, 1908.
[6] *Loc. cit.*

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him as their most eminent member. Our attitude should not be that of grief at his loss, but rather rejoicing that he enjoyed many years of usefulness after the age when most men's work is done; he lived to see the great works he had undertaken completed, and he is now saved from the suffering which at the end rendered life a burden to him.

"Professor Hough's activity in science extended over many years. We remember, even at our last meeting, his interest in our work and plans. His observations with the Evanston telescope, at one time the largest in the world, were maintained for nearly thirty years."

The president then discussed the present needs of astronomy and expressed the hope that the society might take active part in supplying them. One of the greatest needs is a number of small grants, not exceeding a thousand dollars each, which could be used with the sole object of securing the greatest scientific return. If made to the larger observatories, careful organization and system would permit a large amount of routine work to be secured. If made to a small observatory, or to an amateur, the skill and experience of an expert in his own specialty might be secured, with results far beyond those which could be obtained by another astronomer, however skilful in other lines of work. The only way to supply such needs is to make them known. President Pickering invited the members of the society to send him examples of such researches. For instance: Professor Bailey is now studying the climate of South Africa, perhaps the best in the world for an astronomical observatory, and will return shortly. He is making visual and photometric observations with a ten-inch telescope, and photographing the Milky Way with a Cook anastigmat, using long exposures. A grant of one thousand dollars would permit this work to be continued for another year by his assistant, thus doubling the results obtained, at a small additional expense.

After the address by the president the following papers were read:

Some Results with a Selenium Photometer: JOEL STEBBINS.

This paper is a report of progress in the method of using selenium for the electrical measurement of starlight. It has been found that the best results are obtained by keeping the selenium at a constant low temperature in an ice pack. During the past summer, the accuracy of the method has been so increased that it is now possible to measure first-magnitude stars with a probable error of less than 0.01 magnitude.

Precautions Necessary in Photographic Photometry: J. A. Parkhurst.

The results of experiments with stellar and laboratory plates, both focal and extra-focal, were shown by curves thrown on the screen; and the possible errors in stellar magnitude arising from each source were indicated. (1) Comparison of developers, gradation very different. (2) Time of development, possible error exceeding one magnitude. (3) Temperature of development, error nearly one magnitude for range of ten degrees Fahrenheit. (4) Effect of sky fog, possible error of half a magnitude for fog of 0.03 of a density unit. (5) Temperature of exposure, difference of 0.1 magnitude for plates at $+17°$ and $-2°$ C. (6) Reduction formulæ for disk diameters of focal images. Error of half a magnitude possible if *log* diameter were used in the formula instead of square root of diameter. (7) Atmospheric absorption. Difference of 0.17 magnitude between the visual and photographic absorptions at 60° zenith distance. (8) Curvature of commercial plates. Error negligible for focal images but might amount to half a magnitude for extra-focal images. (9) Corrections for distance from axis for plates taken 7 mm. from the focus of the Zeiss doublet, amounts to 0.33 magnitude at 3° from the axis. (10) Correction for distance from axis of focal plates might differ by 0.8 magnitude between summer and winter temperatures. (11) Correction for color of stars of solar type is one magnitude. (Details of the work will be published in the *Astrophysical Journal.*)

Standard Photographic Magnitudes: Henrietta S. Leavitt.

Observations for the purpose of determining the absolute photographic magnitudes of a sequence of forty-seven stars near the North Pole have recently been in progress, as described in Harvard College Observatory Circular 150. Sequences of forty stars in the Pleiades and twenty-six stars in *Præsepe* have also been measured, and the results compared with those obtained for the polar stars.

About one hundred and fifty plates were used, taken with eight telescopes. Several methods were employed for determining absolute magnitudes, independent of the visual scale, but all may be grouped in the three following classes:

1. Photographs were taken, diminishing the light by means of screens, or by reducing the aperture of the telescope, and superposing a second exposure of the same length with full light. A similar effect was obtained by attaching an auxiliary prism of very small angle to the object glass; this deflected a part of the light, forming secondary images of the brighter stars.

2. The light was divided by interposing two thin plates of Iceland spar. The positions of the four images of each star furnished the means of determining the relative amount of light in each image.

3. Photographs were taken, having several exposures on the Pole Star, and on the star to be observed, the images being out of focus by varying amounts.

The results obtained by these radically different methods are accordant with each other in the great majority of cases. They also agree closely with the Harvard photometric scale as far as the magnitude 13.2, after allowing for difference of color. We apparently have a satisfactory working basis for determining the magnitudes of stars in all parts of the sky, on an approximately correct scale.

In the discussion that followed Mr. Stebbins's and Miss Leavitt's papers, Messrs. Parkhurst and Humphreys called attention to the large error which might sometimes be incurred by assuming that the absorption of our atmosphere is the same in different azimuths. Professor Pickering remarked that it was the practise to guard against this source of error at Harvard by establishing an arbitrary limit for the residuals obtained with the meridian photometer and similar instruments, and rejecting all observations in which this limit was exceeded.

A Variable Star whose Light Curve Resembles that of R Coronæ Borealis: Annie J. Cannon.

This star, like R *Coronæ Borealis* and RY *Sagittarii*, has long periods of normal brightness followed by sudden fluctuations of large range at irregular intervals. Its position for 1900 is R. A., $5^h 43^m 12^s$; Decl., $+19° 02'.0$. It follows the Durchmusterung star $+19° 1081$ about 3^s and is south $0'.2$.

The Pivots of the Nine-inch Transit Circle of the U. S. Naval Observatory: F. B. Littell.

This paper, which was read by Professor Eichelberger in the author's absence, gave the results of several determinations of these errors. The investigation is valuable not only for its application to the work with this instrument, but is of general interest on account of the experience with various methods for determining inequalities of pivots.

The Algol System, Z Draconis: R. S. Dugan.

The material for this paper consists in 18,384 settings made with the Pickering sliding prism

polarizing photometer, attached to the 23-inch equatorial. Considerably more than half the settings were read and recorded by an assistant. Eleven minima were observed in whole or in part. These minima, together with those observed and published in detail by Graff, gave a graphical determination of new elements. The star at its faintest phase was seldom more than just visible. Under these conditions there was no evidence of variability in the depth of minimum. The mean curve shows a nearly symmetrical primary minimum consisting in a drop of 2.55 magnitudes, and also a secondary minimum of 0.065 magnitudes. Each lasts about six hours. After recovering from primary minimum, the curve keeps on rising slowly for some time, and the beginning and ending of secondary minimum are at a higher level than those of primary minimum. This would indicate ellipticity and reflection. The average surface intensity of one star is 18 times that of the other, and the radius of the fainter lies between 0.98 and 1.86 times that of the brighter. The radius of the orbit is from 3.5 to 5 times the radius of the brighter star.

The Problem of Three Bodies from the Standpoint of Spectroscopy: KURT LAVES.

With the present accuracy in the determinations of velocities in the line of sight the problem of three bodies begins to assume importance in this department of astronomy. The paper dealt with that phase of the subject that is analogous to the lunar problem. The perturbation by the "sun" is broken up into three components, P, T, S, along the radius vector, perpendicular to it and perpendicular to the plane of the orbit, respectively. Calling z' the velocity in the line of sight of the disturbed body, we have $dz'/dt = -P \sin \theta + T \cos \theta$ in which θ is the longitude from the ascending node. P and T may be expressed as functions of θ and when t is also expressed in terms of the same quantity we obtain an equation of the form $z' = F(\theta)$. A comparison with the observed velocity curve leads to a determination of the inequalities involved. The approximation has been carried as far as the second power of the parameter involved.

The Determination of the Moon's Theoretical Spectroscopic Velocity: KURT LAVES.

It was shown that the four quantities V_1, V_2, V_3, V_4, in Campbell's notation, can be calculated by means of tables computed on the basis of the elliptic polar coordinates of the earth and the moon.

$$(1) \qquad V = K \cdot e \cdot \sin \theta$$

will give both V_1 and V_2. V_1 can not exceed 0.50 km. per second, and V_2 is always less than 0.04 km. As the diurnal change in V_1 and V_2 is at most 0.012 km. we may use approximate values of the longitudes of the sun and the moon.

$$(2) \qquad V_3 + V_4 = V_2 \cos E + K_2 (1 + e_2 \cos \theta_2) \\ \sin E \cos \beta_2;$$

this formula is easily proved with the aid of the hodographic circle. The index 2 refers to the moon. For $K_2(1 + e_2 \cos \theta_2)$ tables may be constructed with the argument θ_2, the true anomaly of the moon. The angle E, which is nearly the difference between the longitudes of the sun and the moon, is computed thus:

$$(3) \qquad \tan p_2 = \tan \beta_2 \operatorname{cosec} (\lambda_2 - \lambda) \text{ and} \\ \sin E = \sin \beta_2 \operatorname{cosec} p_2.$$

Tables based on (3) are being computed for various values of β_2. They will be applicable to the planets as well. As the "Nautical Almanac" is planning to discontinue the computation of E the tables here described should be of considerable value to the astrophysicist.

The Effect of Faulty Collimation of the Correcting Lens on the Star Image: J. S. PLASKETT.

The field of the correcting lens used with visual objectives for photographing star spectra is very limited. A slight displacement from the axis disperses the star image, causes a perceptible difference, transversely, in the position of the images due to light of different wave-lengths. It was shown that even the flexure of the telescope is sufficient to produce this effect. The importance of correct adjustment and of compensating for flexure in the effect on exposure time and on the accuracy of radial velocity measurements was pointed out.

The Width of Slit giving Maximum Accuracy: J. S. PLASKETT.

This paper was a continuation and conclusion of one with a similar title presented at the last meeting. It gave results for other instruments of the relative errors of measurement of early type spectra at various slit widths. It was shown that more accordant and accurate values are obtained at a width of about 0.05 mm. than at either narrower or wider slits. Consequently considerable saving of exposure time over that usually given is possible. The bearing of these results on the proportions of the optical parts in spectrographs was also discussed.

The Photographic Doublet of the Dominion Observatory: R. M. MOTHERWELL.

The images produced by the Brashear 8-inch doublet were surrounded by a halo and a series of tests by the Hartmann method showed this to be due to spherical aberration. On the lens being refigured, by the kindness of the Brashear Company, the halo disappeared and it now gives small and sharply defined images with a widely extended field. Diagrams were shown of the aberration at the normal separation of the front elements, at increased separations, as well as after refiguring.

On the Photographs of Comet c 1908 (Morehouse): E. E. BARNARD.

About 350 photographs of this comet were obtained with the three lenses of the Bruce telescope of the Yerkes Observatory. These pictures cover essentially all the more remarkable phenomena of the comet during its visibility in these latitudes, including the extraordinary outbursts or changes that occurred on September 30 and October 15, 1908. The last photograph was obtained here on December 13, 1908, when the comet was close to the horizon. The photograph of December 11 was one of the most remarkable of the entire set. The paper also deals briefly with the possible cause of these extraordinary changes in the tail of the comet.

On Some Experiments in Photographing Enlarged Images of the Planets, direct with the Forty-inch Telescope: E. E. BARNARD.

Experiments have recently been made, with improved facilities, in photographing directly enlarged images of the planets with the 40-inch telescope. Some of the photographs of Jupiter which show the belts well, stand a subsequent enlargement of upwards of two or three inches. Better results are hoped for by the use of a new screen by Mr. Wallace. The results so far show that it is now mainly a matter of favorable definition to secure valuable photographs.

On the Proper Motion of some of the Small Stars in the Dense Cluster M 92 Herculis: E. E. BARNARD.

The visual and photographic measures of the great star clusters show that but little motion exists in any of the small stars composing them. In M 92 *Herculis* motion is shown in several of the smaller stars, amounting in two cases to as much as 5″ a century. These two stars are of magnitude 13.3 and 14. Motion also seems certain in at least three other stars of between magnitude 14 and 15. The next fifty years ought to give us some idea of the relative motion of many of the stars in this cluster. These motions have been brought to light, in this cluster, perhaps because a closer investigation has been made for that purpose than in the case of other clusters.

Lack of Spectroscopic Evidence of a Dispersion of Light in Space: EDWIN B. FROST.

Examination of plates of spectroscopic binaries, taken with the Bruce spectrograph of the Yerkes Observatory, does not give evidence of a difference of radial velocity for different wave-lengths. The star β *Cephei*, having a period of $4^h 34^m$, would appear especially suitable in this connection. A large range of wave-lengths is obtained for this star only on one-prism plates, and on these any such effect would probably be masked by the accidental errors of measurement. Statistics were read for the star μ *Orionis*, which has a short period, 0.77 day. The spectrum has sharp lines, and many plates have been obtained with three prisms. These show no systematic difference of velocity at different wave-lengths. Mention was made of work successfully commenced with one prism in the red end of the spectrum. While intended for a different purpose, these plates would be available also for a wider range of wave-length in this connection.

Vertical Temperature Gradients in the Atmosphere as Determined by Season and by Types of Weather: W. J. HUMPHREYS.

A large number of sounding-balloon records were grouped according to season and height of the barometer. The results show that while the difference between summer and winter temperatures is most pronounced at the surface of the earth, it is still decided—about half as great—at the highest elevations thus far reached, and that this difference remains essentially constant above an elevation of about ten kilometers, or in the isothermal region. The seasonal effect therefore extends presumably through the entire atmosphere. On grouping into separate curves the summer gradients obtained during high and low barometric conditions, respectively, it is seen that the high barometer, or clear weather conditions, insure higher temperatures than does the low barometer at the surface of the earth and up to near the isothermal region where the conditions are just the reverse; that is, colder in clear than in cloudy weather. Barometer changes have the same effect on the temperature gradients both winter and summer, except at the surface of the earth. Here the temperature is the lowest in winter during clear weather, or high barometer,

and highest under the same conditions during summer. The low barometer gives exactly opposite results. All these phenomena can be explained as the results of radiation and absorption, especially as modified by condensation and varying amounts of water vapor in the atmosphere.

A Proposed Method of Studying Solar Radiation at Great Altitudes: W. J. HUMPHREYS.

The fact that the solar spectrum is limited to wave-lengths greater than 2,900 Ångström units, makes it desirable to determine whether this limitation is due to atmospheric or to solar absorption. High mountain observations have not definitely settled the question and therefore observations at much greater elevations would be desirable. It is proposed to send small automatic spectrographs to great altitudes with sounding balloons. A suitable spectrograph for this purpose was described with a method for securing proper illumination of the slit and exposure at any predetermined altitude.

Planetary Magnetism of the Sun: W. J. HUMPHREYS.

Assuming an ionization and electric separation in the sun's atmosphere sufficient to account for the magnetic condition that Hale has found in the spots, and assuming unit magnetic permeability, or that which obtains for all known substances at high temperatures, it is easy to compute the magnetic field of the rotating sun as a whole. This would be sufficient to produce a magnetic separation, in the case of the more sensitive lines of only about one one-thousandth of an Ångström unit, an amount too small for certain detection. An absence of measurable polar effects must therefore not be taken to be in conflict with the cyclonic theory of the origin of magnetism in the spots.

New Plans for Tabulating the Moon's Longitude: E. W. BROWN.

These plans having already been put into more or less definite shape, the paper contained an account of those parts of them which presented unusual features. The main difficulty consists in tabulating the very numerous small terms chiefly due to planetary action. The great majority of these can by special devices be put into tables. It is hoped that a machine which has just passed through the experimental stage will enable the computer to obtain the sum of the other small terms with great rapidity for half-daily intervals. An outline was given of the general principles that were used as guides for forming tables, the

interests of the ephemeris computer being placed before those of the single place computer whenever they were at variance. A detailed account of the methods will be published within a few months.

A Proposed Design for an Objective Prism Spectrograph for the Determination of Radial Velocities: FRANK SCHLESINGER.

It is proposed to employ two photographic doublets of say six inches aperture and of nearly equal focal lengths. Before each is to be placed a prism of the same aperture, the refracting edge of the one being turned toward the north and of the other toward the south. Plate glass is to be employed for the sensitive plates and one of them is to be turned with the glass side toward the objective. One of the objections to the use of an objective prism in quantitative work is the effect of changes of temperature upon the dispersion of the prisms. It is proposed to obviate this difficulty by surrounding the entire spectrograph with a temperature case supplied with an automatic temperature control, the light from the stars being admitted to the objectives by means of two sheets of plane-parallel glass. The plates are to be measured by superimposing them and obtaining the distance between corresponding lines in the two spectra of each star. These distances will be affected by the radial velocity and will therefore enable us to compute the latter. After an investigation into the various distortions that the spectrograph would involve, and of the sources of error to which the measures would be liable, it was concluded that such a spectrograph would be able to determine the radial velocities of faint stars with a probable error not exceeding ten kilometers for each pair of plates.

Improvements in the Observatory at Ann Arbor: W. J. HUSSEY.

These consist in the overhauling of the director's residence and the installation of instrument shops, a new 37-inch reflector, a single-prism spectrograph and a seismograph.

On Differential Flexure in the Single-prism Spectrograph: R. H. CURTISS.

After calling attention to the serious effect that flexure might exercise in this form of spectrograph, Dr. Curtiss described the device adopted to eliminate it at the Detroit Observatory. As in the case of the Southern Mills three-prism spectrograph and the Mellon single-prism spectrograph of the Allegheny Observatory, the spectrograph box is supported at two points so placed as to make the flexure a minimum. With the Detroit spectrograph Dr. Curtiss has introduced the fur-

ther improvement of making one of these supports adjustable and determining its best position by actual experiment.

The Focal Curves of the Single-material Camera Doublet of the Single-prism Spectrograph of the Detroit Observatory: R. H. CURTISS.

This paper dealt with a recent investigation of the focal curves from λ 3900 to λ 6000 of the new camera lens mentioned in the title. The collimator is an Isokumat of 27.5 inches focus and 1.4 inches aperture. The camera lens has a focus of 16 inches. Nine different combinations of collimator and prism settings were tried covering all cases that might be advantageous. It was found that the deviation from straightness of the focal curves was practically the same in all cases over a distance of 34 mm. But for the portion of the curve corresponding to the interval λ 4000 to λ 5900 the deviations were least for minimum deviation settings in the neighborhood of λ 4400. It was found that the entire region from λ 3900 to λ 6000 could be photographed in sharp focus upon one negative.

The New Spectrograph Measuring Engine of the Detroit Observatory: R. H. CURTISS.

This engine was constructed from designs by Dr. Curtiss based upon his experience with instruments of the Zeiss, Toepfer and Gaertner types as well as with one made by the John A. Brashear Company for the Allegheny Observatory after designs by Professor Schlesinger. The principal features are: a sector for inclining the engine at any desired angle; a long clock spring for taking up the back-lash of the screw; a reversible secondary plate carriage; a motion of rotation of the microscope around an axis parallel to the screw; the use of an interrupted reticle and a removable reticle holder to carry glass reticles of any type. The screw of the engine was made at the observatory shop and seems to possess a remarkable accuracy.

Solar Spectroscopic Observations: PHILIP FOX.

Results in three lines of work were presented: (1) Spectrograms of a dark calcium flocculus that had a high velocity. (2) A brief report on the work undertaken by Dr. Abetti and the author on the sun-spot spectrum. The photographs were obtained with an 18-foot Littrow spectrograph used with an horizontal telescope of 60 feet focal length. The investigation covers the region from λ 3900 to λ 6800 and includes about 8,000 altered lines. (3) A preliminary report concerning a comparative study of the spectra of the details of the photospheric granulation.

The Use of Quartz Fibers for Micrometer Wires: PHILIP FOX.

Spider-threads, while excellent in many ways, have two disadvantages: they are affected by humidity and they are too coarse. It is a difficult matter to find spider threads whose diameters do not exceed the resolving power of the telescope. The author has made some experiments with quartz fibers furnished by Professor Nichols. There was no difficulty in finding and mounting fibers that were one third of the usual diameter of spider threads. They are very smooth and do not readily retain dust particles, they are easily illuminated and are not affected by changes in humidity. One fiber has been in use for more than a year.

In the discussion that followed this paper attention was called to the fact that owing to the non-elastic qualities of the fiber there was a tendency for it to work loose from the mounting, under the temperature conditions that usually prevail at a telescope.

Some Dynamical Considerations on Globular Star Clusters: F. R. MOULTON.

The assumption on which this paper was based is that the dimensions, masses and relative velocities in the globular star clusters are such that they maintain essentially constant dimensions. Consequently, if this assumption is sound, when two of the three classes of data are furnished by observations, the third, *e. g.*, the masses, is given by the equational relation which is developed.

If π is the parallax of the cluster, D the diameter of the cluster in the same units, N the number of stars in it, then ρ, the average distance between adjacent stars, is

$$\rho = \frac{D}{\sqrt[3]{N\pi}}.$$

If $N = 5,000$, $D = 30'$, $\pi = 0''.01$, which is the mean parallax of fifth magnitude stars according to Kapteyn's formula, we have $\rho = 10,500$ astronomical units.

An important question in the discussion is whether a star passing through the cluster has many close approaches to other stars, and whether it may be prevented from leaving the cluster by the general gravitative control of the whole group of stars. If R is the radius of the cluster in astronomical units, the probability, P, that a star passing through the cluster will pass within r astronomical units of at least one other star is

$$P = \frac{3}{2}\left(\frac{r}{R}\right)^2 N.$$

With $r = 10$ and the data assumed above, we have $P = 1/43,000$. Hence near approaches in such a system are extremely rare.

The period of revolution of a star in a star cluster of approximately homogeneous star distribution, is

$$T = \frac{2\pi R^3}{k\sqrt{M}},$$

where M is the total mass. Supposing $M = 5,000$ times the sun's mass and the other data as above, we find $T = 89 \times 10^{12}$ years.

The greatest velocity is

$$V = \frac{k\sqrt{M}}{\sqrt{R}}$$

at the center of the cluster. With the data used above, $V = 1.04$ astronomical units per year; or, in angular measure, as a maximum, $0''.01$ per year. The apparent angular velocity varies with the three-halves power of the parallax. Consequently if the large value taken above is actually ten times too great, the greatest apparent angular velocity is only $0''.0003$ per year. If these numerical assumptions be regarded as reasonable, then sensible relative motions of permanent members of star clusters are not to be expected until the observations extend over some decades.

Achromatic and Apochromatic Comparative Tests —Second Communication: E. D. ROE, JR.

This paper presented the final results of the testing of two objectives, which was outlined a year ago in a preliminary communication before the society. The two objectives, two-lens type achromatic and apochromatic telescope objectives of approximately the same aperture and focal length, by Mr. Lundin and Steinheil Söhne, respectively, were tested visually on double stars, and in the laboratory the photographic knife edge test was applied to both objectives with satisfactory results, while the color curves of the two lenses were ascertained by measurements on extra- and intra-focal spectrograms. The paper will appear in *Archiv für Optik* (Berlin).

Report of Progress on the Radial Velocity Program of the Lick Observatory: W. W. CAMPBELL.

The programs of observation for the Mills spectrograph attached to the 36-inch equatorial, and for the D. O. Mills expedition to the southern hemisphere (Santiago, Chile) have aimed to secure at least four spectrograms of every star down to the 5.0 visual magnitude, with 3-prism disper-

sion if possible, and of somewhat fainter stars, especially in the southern hemisphere, with 2-prism dispersion. Up to June 1, 1909, 3-prism spectrograms of 882 stars had been obtained at Mt. Hamilton; 200 of these, whose spectra contain broad and poorly defined lines, have been rejected from the main program for observation later with lower dispersion. Excepting these, the northern observing program is essentially complete for the good summer months; and if next winter, and especially next spring, have average weather conditions, the program should be nearly complete throughout the twenty-four hours of right ascension, by June 1, 1910. The D. O. Mills expeditions, under Astronomers Wright and Curtis, successively, have observed altogether 530 stars brighter than 5.01 visual magnitude and about 150 stars fainter than 5.00 magnitude, or 680 stars in all. Correcting for those stars observed at both Mt. Hamilton and Santiago, the total number of stars whose spectra have been photographed is 1,368. The original Mills spectrograph was succeeded in May, 1903, by a new Mills spectrograph. All the spectrograms obtained with the original spectrograph, and about three fourths of those obtained with the new spectrograph, have been measured and reduced definitively, and are being rapidly prepared for publication. During the first period of the D. O. Mills expedition, in charge of Astronomer Wright, covering two years of observation, spectrograms of about 200 stars were secured. Those containing lines suitable for accurate measurement numbered 148, and four plates, on the average, were obtained for each of these. The results, including all the text, are entirely ready for publication in volume form. Of these 148 stars, 29, or one in five, have been found to have variable velocities. Of the plates secured during the second period of the D. O. Mills expedition, under Astronomer Curtis, about one third have been measured and reduced definitively by Dr. Curtis and his assistant, Mr. Paddock, while carrying on the work of observing. The remainder have been measured approximately —that is, utilizing only a few of the available lines. It should be said that only a small proportion of the spectroscopic binaries discovered at Mount Hamilton and in Chile have been investigated. To do this would require several years of observing, measurement and computation.

The Lick Observatory Double-star Survey—A Report of Progress: R. G. AITKEN.

The program for this survey as originally planned contemplated the examination of every

ther improvement of making one of these supports adjustable and determining its best position by actual experiment.

The Focal Curves of the Single-material Camera Doublet of the Single-prism Spectrograph of the Detroit Observatory: R. H. Curtiss.

This paper dealt with a recent investigation of the focal curves from λ 3900 to λ 6000 of the new camera lens mentioned in the title. The collimator is an Isokumat of 27.5 inches focus and 1.4 inches aperture. The camera lens has a focus ot 16 inches. Nine different combinations of collimator and prism settings were tried covering all cases that might be advantageous. It was found that the deviation from straightness of the focal curves was practically the same in all cases over a distance of 34 mm. But for the portion of the curve corresponding to the interval λ 4000 to λ 5900 the deviations were least for minimum deviation settings in the neighborhood of λ 4400. It was found that the entire region from λ 3900 to λ 6000 could be photographed in sharp focus upon one negative.

The New Spectrograph Measuring Engine of the Detroit Observatory: R. H. Curtiss.

This engine was constructed from designs by Dr. Curtiss based upon his experience with instruments of the Zeiss, Toepfer and Gaertner types as well as with one made by the John A. Brashear Company for the Allegheny Observatory after designs by Professor Schlesinger. The principal features are: a sector for inclining the engine at any desired angle; a long clock spring for taking up the back-lash of the screw; a reversible secondary plate carriage; a motion of rotation of the microscope around an axis parallel to the screw; the use of an interrupted reticle and a removable reticle holder to carry glass reticles of any type. The screw of the engine was made at the observatory shop and seems to possess a remarkable accuracy.

Solar Spectroscopic Observations: Philip Fox.

Results in three lines of work were presented: (1) Spectrograms of a dark calcium flocculus that had a high velocity. (2) A brief report on the work undertaken by Dr. Abetti and the author on the sun-spot spectrum. The photographs were obtained with an 18-foot Littrow spectrograph used with an horizontal telescope of 60 feet focal length. The investigation covers the region from λ 3900 to λ 6800 and includes about 8,000 altered lines. (3) A preliminary report concerning a comparative study of the spectra of the details of the photospheric granulation.

The Use of Quartz Fibers for Micrometer Wires: Philip Fox.

Spider-threads, while excellent in many ways, have two disadvantages: they are affected by humidity and they are too coarse. It is a difficult matter to find spider threads whose diameters do not exceed the resolving power of the telescope. The author has made some experiments with quartz fibers furnished by Professor Nichols. There was no difficulty in finding and mounting fibers that were one third of the usual diameter of spider threads. They are very smooth and do not readily retain dust particles, they are easily illuminated and are not affected by changes in humidity. One fiber has been in use for more than a year.

In the discussion that followed this paper attention was called to the fact that owing to the non-elastic qualities of the fiber there was a tendency for it to work loose from the mounting, under the temperature conditions that usually prevail at a telescope.

Some Dynamical Considerations on Globular Star Clusters: F. R. Moulton.

The assumption on which this paper was based is that the dimensions, masses and relative velocities in the globular star clusters are such that they maintain essentially constant dimensions. Consequently, if this assumption is sound, when two of the three classes of data are furnished by observations, the third, *e. g.*, the masses, is given by the equational relation which is developed.

If π is the parallax of the cluster, D the diameter of the cluster in the same units, N the number of stars in it, then ρ, the average distance between adjacent stars, is

$$\rho = \frac{D}{\sqrt[3]{N\pi}}.$$

If $N = 5,000$, $D = 30'$, $\pi = 0''.01$, which is the mean parallax of fifth magnitude stars according to Kapteyn's formula, we have $\rho = 10,500$ astronomical units.

An important question in the discussion is whether a star passing through the cluster has many close approaches to other stars, and whether it may be prevented from leaving the cluster by the general gravitative control of the whole group of stars. If R is the radius of the cluster in astronomical units, the probability, P, that a star passing through the cluster will pass within r astronomical units of at least one other star is

$$P = \frac{3}{2}\left(\frac{r}{R}\right)^2 N.$$

With $r = 10$ and the data assumed above, we have $P = 1/43,000$. Hence near approaches in such a system are extremely rare.

The period of revolution of a star in a star cluster of approximately homogeneous star distribution, is

$$T = \frac{2\pi R^3}{k\sqrt{M}},$$

where M is the total mass. Supposing $M = 5,000$ times the sun's mass and the other data as above, we find $T = 89 \times 10^{12}$ years.

The greatest velocity is

$$V = \frac{k\sqrt{M}}{\sqrt{R}}$$

at the center of the cluster. With the data used above, $V = 1.04$ astronomical units per year; or, in angular measure, as a maximum, $0''.01$ per year. The apparent angular velocity varies with the three-halves power of the parallax. Consequently if the large value taken above is actually ten times too great, the greatest apparent angular velocity is only $0''.0003$ per year. If these numerical assumptions be regarded as reasonable, then sensible relative motions of permanent members of star clusters are not to be expected until the observations extend over some decades.

Achromatic and Apochromatic Comparative Tests —Second Communication: E. D. ROE, JR.

This paper presented the final results of the testing of two objectives, which was outlined a year ago in a preliminary communication before the society. The two objectives, two-lens type achromatic and apochromatic telescope objectives of approximately the same aperture and focal length, by Mr. Lundin and Steinheil Söhne, respectively, were tested visually on double stars, and in the laboratory the photographic knife edge test was applied to both objectives with satisfactory results, while the color curves of the two lenses were ascertained by measurements on extra- and intra-focal spectrograms. The paper will appear in *Archiv für Optik* (Berlin).

Report of Progress on the Radial Velocity Program of the Lick Observatory: W. W. CAMPBELL.

The programs of observation for the Mills spectrograph attached to the 36-inch equatorial, and for the D. O. Mills expedition to the southern hemisphere (Santiago, Chile) have aimed to secure at least four spectrograms of every star down to the 5.0 visual magnitude, with 3-prism disper-

sion if possible, and of somewhat fainter stars, especially in the southern hemisphere, with 2-prism dispersion. Up to June 1, 1909, 3-prism spectrograms of 882 stars had been obtained at Mt. Hamilton; 200 of these, whose spectra contain broad and poorly defined lines, have been rejected from the main program for observation later with lower dispersion. Excepting these, the northern observing program is essentially complete for the good summer months; and if next winter, and especially next spring, have average weather conditions, the program should be nearly complete throughout the twenty-four hours of right ascension, by June 1, 1910. The D. O. Mills expeditions, under Astronomers Wright and Curtis, successively, have observed altogether 530 stars brighter than 5.01 visual magnitude and about 150 stars fainter than 5.00 magnitude, or 680 stars in all. Correcting for those stars observed at both Mt. Hamilton and Santiago, the total number of stars whose spectra have been photographed is 1,368. The original Mills spectrograph was succeeded in May, 1903, by a new Mills spectrograph. All the spectrograms obtained with the original spectrograph, and about three fourths of those obtained with the new spectrograph, have been measured and reduced definitively, and are being rapidly prepared for publication. During the first period of the D. O. Mills expedition, in charge of Astronomer Wright, covering two years of observation, spectrograms of about 200 stars were secured. Those containing lines suitable for accurate measurement numbered 148, and four plates, on the average, were obtained for each of these. The results, including all the text, are entirely ready for publication in volume form. Of these 148 stars, 29, or one in five, have been found to have variable velocities. Of the plates secured during the second period of the D. O. Mills expedition, under Astronomer Curtis, about one third have been measured and reduced definitively by Dr. Curtis and his assistant, Mr. Paddock, while carrying on the work of observing. The remainder have been measured approximately —that is, utilizing only a few of the available lines. It should be said that only a small proportion of the spectroscopic binaries discovered at Mount Hamilton and in Chile have been investigated. To do this would require several years of observing, measurement and computation.

The Lick Observatory Double-star Survey—A Report of Progress: R. G. AITKEN.

The program for this survey as originally planned contemplated the examination of every

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star to the magnitude 9.0 in the Bonn Durchmusterung from the north pole to declination 22° south, with the object of securing data for a statistical study of double stars. Since 1905, when Professor Hussey left the observatory, the work has been carried on by the author alone. It should be completed in two years' time, provided that the observing conditions between December and June are reasonably good. At present about 85 per cent. of the area has been examined; 3,375 close double stars have been added to those previously known and of these 1,327 are to Professor Hussey's credit. One star in eighteen of those examined has proved to be a double with a separation under 5″. It appears that double stars with a separation under 2″ are far more numerous than those between 2″ and 5″. The discussion of the material thus far collected is under way, but definitive results will not be forthcoming until the survey has been extended to the south pole. It is hoped that an expedition suitably equipped to carry out this program may be sent to South America by the Lick Observatory immediately upon the conclusion of the present survey.

Spectrographic and Photographic Observations of Comet c 1908 (Morehouse): HEBER D. CURTIS.
Between the dates February 23 and March 23, 1909, one slit spectrogram and seventeen objective-prism spectrograms were secured at the observatory of the D. O. Mills expedition. With the slit spectrograph it was found possible to obtain only the strongest of the pairs of lines of unknown origin which characterized this comet. The wave-lengths of this pair as derived from the slit spectrogram are λ 4254.2 and λ 4275.4.

The following are the wave-lengths as derived from the objective-prism plates: λ 3914.1, λ 4002.1, λ 4021.3, λ 4254.0, (λ 4276.0), λ 4526.0 $\pm$, λ 4545.9, λ 4570.2, λ 4690.7, λ 4716.3. Collecting the differences for the three strongest pairs of lines, λ 4002–21, λ 4254–76, λ 4546–70, together with the corresponding angles at the comet between the radius vector and the line connecting the comet with the earth, we have:

Observer	Date	$\Delta\lambda_1$	$\Delta\lambda_2$	$\Delta\lambda_3$	Angle
Deslandres and Bernard	1908 Oct. 14	20	23	20±	39°9
Deslandres and Bosler	Nov. 1	19.7	21.6	22.0	46 3
Campbell and Albrecht	Nov. 28	19.6	20.7	20.8	37.2
Curtis	1909 Feb. 25	18.5	22 0	24.5	39.7
Curtis	Mar. 21	19 4	22 5	23.8	35.6

The objections to interpreting the doubling of these lines as a Doppler-Fizeau effect have already been stated by Campbell and Albrecht (cf. Lick Observatory Bulletin, No. 147). Assuming the actual velocities along the tail or transverse to the tail to have been the same when Deslandres and Bosler observed on November 1 and when the author observed on March 21, the mean of the intervals for the three principal pairs of lines should have been about four tenth-meters greater, or less, respectively, on March 21 than on November 1, whereas the observed intervals were not quite one tenth-meter greater on the latter date.

The various spectral images are replicas of the tail, as shown by the direct photographs taken at the same dates, as far as can be made out on the small scale of the plates. In this respect the plate of March 20 is of especial interest. The direct photograph on this night shows a marked curve in the tail about half a degree from the head, a curve which is duplicated in each of the spectral images.

Twenty-eight direct photographs of the comet were also made during this period, the majority of them with a 6½ inch portrait lens; many of these plates show interesting evidences of the extraordinary activity which characterized this comet both before and after perihelion.

Three Stars of Great Radial Velocity: HEBER D. CURTIS.
A number of stars with proper motions of 1″.0 per year or greater have been investigated with the spectrographs of the D. O. Mills expedition to the southern hemisphere, and in the course of this work three stars have been found with radial velocities of unusual magnitude. Of these the most interesting is the star Cordoba Zones 5^h243 ($\alpha = 5^h 7^m.4, \delta = -44° 56'$) whose proper motion of 8.7 seconds of arc per year is the greatest thus far observed. Its magnitude is 9.2, and its photographic magnitude about 10.5, so that a satisfactory plate was secured only by prolonging the exposure time to twenty-nine hours on four consecutive nights. The mean of two plates shows that the star is receding from the sun at a rate of 242 km. per second. Using the Cape value of the parallax of this star, 0″.312, with Kapteyn's values for the proper motion in right ascension and declination, and eliminating the motion of the solar system in accordance with Campbell's value, the resulting space velocity of this star is about 261 km. per second, directed toward a point whose coordinates are $a = 122°, \delta = -60°$. This enormous space velocity seems to be exceeded only by the star 1830 Groombridge, which is traveling at a rate of about 278 km. per second toward an apex in $a = 250°, \delta = -52°$. From five plates

a velocity of recession of 100 km. per second was found for the star Lacaille 2957, and a velocity of approach of 132 km. per second in the case of the star Lacaille 8362, derived from three plates.

Thirteen Stars having Variable Radial Velocities: HEBER D. CURTIS.

This paper gave a list of thirteen new spectroscopic binaries discovered during the past two years in the course of the work of the D. O. Mills expedition to the southern hemisphere. Eight of the number were discovered by Dr. Curtis, and five by Mr. George F. Paddock. In two cases the spectra of both components of the system are visible.

Note on the Apparent Wave-lengths of Lines in the Different Spectral Types and in Certain Variable Stars: SEBASTIAN ALBRECHT.

In 1906 the author made an investigation of the individual spectrum lines in certain spectrograms, with a view of determining whether there is a shift of any of the lines which is progressive from spectral type to type. A preliminary list of lines which undergo such a change, as indicated by the radial velocities obtained from them, was published in November, 1906. This investigation has been continued intermittently during the last two years, and a number of additional lines have been found whose positions also change progressively.

In the paper referred to, a comparison was made with Mr. Adams's list of sunspot lines (*Aph. Jour.*, 24, 1906). The principal result of the comparison was the strong indication that the physical conditions in the stars as we pass from the F to the Mb type vary roughly in the same direction as from the sun to the sunspots. The results for the additional lines are in harmony with the above conclusion.

In his first paper the author expressed the opinion that for variable stars of large light changes similar changes of apparent wave-lengths of line might be found, corresponding to changes in spectral type from maximum to minimum. Measures of the available spectrograms of the fourth class variables η *Aquilæ* and 1 *Carinæ* were tabulated according to phase of light variation and some lines in the case of each star were found to show a variation dependent upon the phase of the light curve. In general, the direction of variation is such as to indicate a later spectral type at minimum than at maximum, though the variation does not in each case take place in the same part of the light curve. The change in the spectrum of the variable star is probably such

that the spectrum always has some characteristics of more than one spectral type.

Unpublished Work of the Harvard Observatory: EDWARD C. PICKERING.

Discussion of the Revised Harvard Photometry, *H. A.*, 64, 4, pp. 56; ready for distribution.

Observations on J. D. 3182 with the Four-inch Meridian Photometer, *H. A.*, 64, 5, pp. 12; ready for printing.

Magnitudes of Components of Double Stars, *H. A.*, 64, 6, pp. 34; in type.

A Discussion of the Eclipses of Jupiter's Satellites, 1878–1903, by Ralph A. Sampson, *H. A.*, 52, 2, pp. 190; in type.

Durchmusterung Zones Observed with 12-inch Meridian Photometer, 190 pages; in type.

Maxima and Minima of Variable Stars of Long Period, 130 pages; in type.

Photometric Measurements made with the East Equatorial, by Oliver C. Wendell, pp. 56; in type.

Photographic Magnitudes of Seventy-two Bright Stars, Photographic Observations of Occultations, Eclipses of Jupiter's Satellites, Transformation of Prismatic to Normal Spectra, Miscellaneous, by Edward S. King; nearly ready for printing.

Statistical Investigations of Planetary Orbits, by W. H. Pickering; nearly ready for printing.

The Zone of Stars, in declination — 9° 50′ to — 14° 10′, observed by Professor Searle with the eight-inch meridian circle, is now nearly completed. It will occupy three volumes of the *Harvard Annals*. It will be sent to the printer this autumn, unless unforeseen delays arise.

The Photographic Search for Planet O: W. H. PICKERING.

The search for this planet was prosecuted on plates taken by the Rev. Joel H. Metcalf with his 12-inch doublet. Two plates of each region were taken at intervals of a few days apart. A positive was printed from one of these, and the other negative superposed upon it. It was expected to detect the planet by its motion during the interval elapsed. The planet has not as yet been found. This may be due to one or more of three causes: (*a*) The planet may be unexpectedly faint, or reddish in color. Its computed magnitude is 13.5. (*b*) The orbit may be highly eccentric, the computation being based on an approximately circular orbit. (*c*) The orbit may be highly inclined to the ecliptic, and the planet at present situated far from its node. For various reasons the first two causes are not thought sufficiently effective to interfere with the discovery of the planet. We might, by analogy, compare planet *O* on account

of its relative size and position with regard to the other planets, to the sixth or seventh satellite of Jupiter. The inclinations of the orbits of these two bodies are 28° and 26°, respectively. The region already covered in the photographic search extends along the ecliptic for 25°, and reaches to a maximum distance of 10° to the north and south of it. It is expected therefore to make an examination of the higher latitudes next year. The number of stars already examined in the search is estimated at about 300,000.

The Spectrum of a Meteor: WILLIAMINA P. FLEMING.

On August 14, 1909, while examining a shipment of plates recently received from Arequipa the spectrum of a meteor was found on a photograph taken with the Bruce 24-inch telescope on May 18, 1909. This must have been an unusually bright object, since its trail is very intense, consisting of twenty-three bright lines or bands. As the photograph has so recently been received at Cambridge no study of the spectrum has as yet been attempted.

Graduation Errors of the Circles of the Six-inch Transit Circle of the U. S. Naval Observatory: J. C. HAMMOND.

This consisted of a description of the methods and results of a thorough examination of the circles that is still in progress. The circles were graduated by the Warner and Swasey Company, of Cleveland, and seem to be quite as accurate as those of the best foreign makers. The examination brought to light a periodic error that repeated itself in every ten minutes of arc. This was traced to a slight eccentricity of a ratchet-wheel and has been corrected for circles subsequently graduated with this engine.

The Clock Vault of the U. S. Naval Observatory: EDGAR TILLYER.

In this paper, which was read by Professor Updegraff in the absence of the author, Mr. Tillyer described the devices adopted for maintaining constant temperature in the vault in which are mounted three Riefler clocks.

On the Construction of Astronomical Photographic Objectives at the U. S. Naval Observatory: GEORGE H. PETERS.

Mr. Peters first described the various attempts that had been made to install a photographic instrument at the observatory with the use of material already at hand, the most noteworthy of these being the reassembling of the parts of the old mounting of the 26-inch equatorial to serve as a mounting for various cameras. Mr. Peters has now undertaken the construction of two 10-inch objectives of about 110-inch focus. These are of the type in which three lenses are employed with large separations. The curves were computed by Mr. Tillyer and the grinding is being done with a machine constructed in the observatory shop.

At the annual meeting of 1908 the society had appointed a committee on luminous meteors. This committee presented a detailed report written by its chairman, Professor Cleveland Abbe, giving a résumé of what had previously been done toward securing photographs of meteor trails. The various methods and instruments that have been employed or proposed were critically examined from the point of view of the astronomer as well as from that of the meteorologist. The report strongly urged the establishment of a network of photographic stations about one hundred miles apart for the purpose of obtaining a tolerably complete record of all the meteors appearing within the network. Automatic instruments of as simple and inexpensive a type as practicable were recommended.

The committee on comets, also appointed at the 1908 meeting, reported orally through its chairman, Professor Comstock. Its attention had been given mainly to the approaching return of Halley's comet. In order that this comet may be adequately observed it will be necessary, on account of its close approach to the sun at the time of maximum brilliancy, to have stations widely distributed in longitude. To secure such stations correspondence has been had with observatories in the eastern hemisphere. The Pacific Ocean presents a wide gap in which no available station exists and the committee has assumed the task of securing funds for the establishment of a temporary station, presumably in the Hawaiian Islands. Such funds are now assured in case the circumstances of the comet's return render it desirable to send out a party. The appearances that the comet will present depend so much upon the exact date of its return to perihelion that no definitive program of observation can be framed before the rediscovery of the comet. It appears, however, advisable to separate the observing program into three classes of observations, viz., photographic, photometric and spectrographic, and the preparation of a detailed program of these divisions has been entrusted, respectively, to Professors Barnard, Pickering and Frost. It is the

purpose of the committee as soon as it has adequate data at its disposal to formulate and publish the proposed program under these several heads.

A proposal to change the name of the society to the American Astronomical Society was discussed at considerable length. It was the feeling of most of the members present that such a change would be desirable from some points of view; as, however, fears were expressed that this change might tend to deprive the society of the great benefits that it now derives from the attendance and contributions of some who engaged altogether in laboratory research, it was voted not to omit the word "Astrophysical" from the name of the society.

A proposal that the society should go on record as deeming any attempt to communicate with Mars as being unpracticable at the present time and as deprecating the use of any funds for such a purpose was also voted down. The members present were unanimous in believing that such attempts are useless, but were of the opinion that it would be wise not to dignify with any formal action the absurd accounts that have recently appeared in the newspapers.

Upon recommendation by the council the society decided to issue a volume giving an account of its activities during the first ten years of its existence. The council announced that thirty-four persons, an unusually large number, had been elected to membership at this meeting; and that the next meeting would be held during August, 1910, at the Harvard College Observatory, the exact date to be determined later.

The last formal action to be taken by the society before its adjournment was the unanimous adoption of the following:

"The Astronomical and Astrophysical Society of America, assembled at its tenth annual session, records its great regret at the death of its first president, Professor Simon Newcomb. Deeply interested in the cooperation and mutual influence of scientific men, Professor Newcomb was conspicuous in the organization and early progress of the society, and was a dominant factor in determining its relation to contemporary astronomy. His enthusiasm for the science and his wide knowledge of its many branches made his presence and participation in the meetings of the society a perennial inspiration to its members.

"Professor Newcomb's own achievements in exact and theoretical astronomy have already become classics in the history of the subject, and will constitute his permanent memorial. The record of a long and active scientific career is closed with the fulfilment of many of his most cherished ideas, and we deeply regret that he was not longer spared for the further development of those subjects to which he had largely contributed.

"The society records its profound respect for the departed member and directs its secretary to transmit a copy of these resolutions to his bereaved family."

FRANK SCHLESINGER,
Editor for the Tenth Annual Meeting

SOCIETIES AND ACADEMIES
THE AMERICAN MATHEMATICAL SOCIETY

THE one hundred and forty-fifth regular meeting of the society was held at Columbia University on Saturday, October 30, 1909, extending through a morning and an afternoon session. About forty persons were in attendance, including twenty-seven members of the society.

Vice-president Edward Kasner occupied the chair, being relieved at the afternoon session by ex-presidents W. F. Osgood and H. S. White. The following persons were elected to membership: Dr. H. T. Burgess, University of Wisconsin; Professor H. H. Dalaker, University of Minnesota; Mr. G. C. Evans, Harvard University; Mr. Louis Gottschall, New York City; Dr. J. V. McKelvey, Cornell University; Miss H. H. MacGregor, Yankton College; Mr. H. H. Mitchell, Princeton University; Mr. U. G. Mitchell, Princeton University; Mr. R. R. Shumway, University of Minnesota; Dr. H. L. Slobin, University of Minnesota; Mr. I. W. Smith, University of North Dakota. Four applications for membership in the society were received. Mr. C. B. Upton, of Teachers College, was appointed assistant librarian of the society.

Resolutions were adopted expressing the sense of loss to the society and to science occasioned by the death of Ex-president Simon Newcomb.

The following papers were read at this meeting:

C. N. Haskins: "On the extremes of functions."

P. A. Lambert: "On the solution of linear differential equations."

Florian Cajori: "Note on the history of the slide rule."

Carl Runge: "A hydrodynamic problem treated graphically."

Edward Kasner: "The motion of particles starting from rest."

G. A. Miller: "Note on the groups generated by two operators whose squares are invariant."

C. N. Moore: "On the uniform convergence of

the developments in Bessel functions of order zero."

The Southwestern Section of the society will meet at the University of Missouri on Saturday, November 27. The winter meeting of the Chicago Section will be held at the University of Chicago on Friday and Saturday, December 31 and January 1. The annual meeting of the society will be held at Boston, in affiliation with the American Association, Tuesday to Thursday, December 28–30. F. N. COLE,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 669th meeting was held in the West Hall of George Washington University, on October 23, 1909, President Wead in the chair. The following papers were read:

A Mechanical Means for Effecting Certain Conformal Transformations: Dr. R. A. HARRIS, of the Coast and Geodetic Survey.

Attention was called to the fact that a mechanism which sums continuously and simultaneously two trigonometrical series, the one consisting of sine terms, the other of cosine terms, may be readily adapted to conformal transformations. The independent variable z is assumed to describe circular paths concentric about the origin in the z-plane, and through interruptions at regular intervals, to indicate the orthogonal paths which are radiating straight lines through the origin. Z will describe a system of curves in the Z-plane corresponding to the circles, while the interruptions in the Z-motion will define a system of orthogonal curves corresponding to the radial lines in the z-plane.

We have in general:

$$Z = Az^a + Bz^b + \cdots = X + iY$$
$$= \mathrm{mod}\ Ar^a\ [\cos\ (a\theta + a) + i\ \sin\ (a\theta + a)]$$
$$+ \mathrm{mod}\ Br^b\ [\cos\ (b\theta + \beta) + i\ \sin\ (b\theta + \beta)]$$
$$+ \cdots \cdots \cdots$$

where r denotes the modulus, and θ the argument, of z. The arguments of A, B, $\cdots$ are a, β, $\cdots$. The exponents a, b, $\cdots$ are real numbers and may be positive or negative, integral or fractional. The motion of Z is the resultant of the motions along X and Y. These two rectilinear motions can be produced simultaneously by a mechanism similar to that described by W. H. L. Russell in the *Proceedings of the Royal Society of London*, Vol. 18, 1869.

When only two powers of z are involved in the expression for Z, a very simple instrument can be used in effecting the required transformation; viz., an instrument which continuously combines two circular motions. Such an instrument consists essentially of two graduated arms or cranks, made to revolve with the required angular velocities by means of suitable gears, and a parallelogrammic arrangement so connecting the revolving arms that at each instant the half sum of the two circular motions is indicated by a tracing point.

Attention was called to numerous examples, such as $Z = z + Bz^{-b}$, $Z = z - Bz^b$, where B and b are real positive quantities; $Z = z + 1/z$, $Z = z + z^2$, $Z = z + z/\nu$, etc.

A mechanism capable of performing a considerable variety of transformations like these was exhibited before the society; also a small copper plate upon which several curves had been etched mechanically by means of the instrument.

The International Unit of Light; Photometric Units and Nomenclature: Dr. E. B. ROSA, of the Bureau of Standards.

The speaker gave the definitions of seven photometric magnitudes and derived the equations showing the relations between them. These quantities are: (1) the *intensity*, (2) *luminous flux*, (3) *illumination*, (4) *radiation*, (5) *brightness*, or *specific intensity*, (6) *the surface integral of the latter over the source*, (7) *quantity of light*, or *the time integral of the flux*. The first three of these quantities are most used in practical photometry and illuminating engineering, but the others are required in a complete system, and it contributes to clear thinking and concise expression to have a separate name for each different quantity. The corresponding names in French and German were given, and some changes in these names suggested that would make the nomenclature in the three languages more nearly uniform. R. L. FARIS,
Secretary

NEW YORK ACADEMY OF SCIENCES—SECTION OF ASTRONOMY, PHYSICS AND CHEMISTRY

A MEETING of this section was held on Monday, October 18, at the American Museum of Natural History. Mr. Edward Thatcher read a paper on "Some Principles in Art Metal Work"; W. Campbell, "On the Structure and Constitution of some Alloys and Metals used in the Arts," and Professor D. W. Hering, on "Wave-length of Light by Newton's Rings." WM. CAMPBELL,
Secretary